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1880	contained	25	different	adv'ts.	1887	contained	154	different	adv'ts.
1881	"	28	"	"	1888	"	175	"	"
1882	"	45	"	"	1889	"	234	"	"
1883	"	68	"	"	1890	"	289	"	"
1884	"	82	"	"	1891	"	325	"	"
1885	"	100	"	"	1892	"	316	"	"
1886	"	138	"	"	1893	"	317	"	"

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No announcements of the Publisher are included in this list.

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THE ELECTRIC RAILWAY IN EUROPE AND AMERICA.

In a recent issue, an esteemed French electrical contemporary, whose editor is an exceptionally fairminded one, ventures to remark that "old Europe was the cradle and America the school" of the electric railway. To this poetical effusion it might have been added for completeness' sake, that the birthplace and parents of the infant were also American. This will doubtless lead many of us to stop and consider what proportion of a successful man's abilities he owes to his parentage and schooling and how much or how little to his cradle. The little story might have been related more completely though less poetically, and with less modesty, about as follows: After being born here of American parents, the baby was taken to Europe where he was rocked and exhibited in his cradle; finding the natives there very thorough but a little too slow for him, he left them and returned to this country to get his schooling; after becoming a man he again went to Europe to teach his former admirers and child nurses what he had learned at school.

A COMPARISON.

Our esteemed contemporary, the "Western Electrician," in its issue of last week takes pleasure in patting itself on the back for what to it was a phenomenal Convention issue, both in size and number of copies printed—the number dated March 3. While we doubt the effect of lengthy calculations of the acreage, etc., of paper used when based upon a sporadic issue of a journal, yet we congratulate our Western contemporary upon the enterprise intended by it, and trust that it will not allow the next seven years of its existence to pass by without marking its end by another heroic effort. This number furnishes an opportunity to determine how an extraordinary Convention issue of our contemporary compares with a usual Convention issue of The Electrical World, and for this purpose we will take our number of the same date, first basing the comparison upon material:

	Number of copies.	Number of pages.	Reams of paper.
The Western Electrician	16,630	56	128
The Electrical World	15,500	124	240

While we must acknowledge that in quantity of material our contemporary exceeds in its extraordinary issue that of its usual edition several times over, and that in advertising it has also there reached a high-water mark, the comparison in the latter respect is not quite so favorable as the above, as will appear from the following figures:

	Pages of advertising.	Number of advertisements.	Inches of advertising.
The Western Electrician	40	157	1,838
The Electrical World	76	386	3,215

In reading matter we fear that a comparison based on quality would be still less favorable to our esteemed Western contemporary, but as we are not aware that it makes any claim of excellence for this part of its Convention or any other issue, we will, therefore, spare it a comparison in that respect.

THE AMERICAN BELL TELEPHONE COMPANY.

The report of the American Bell Telephone Company, which we print elsewhere, has an interest not usually found in business statements. As marking how component a part of business life the telephone has become are the statistics showing how the recent business depression was reflected in that industry. A significant statement is

the amount of money invested during the past nine years upon betterments and extensions of plant, a great part of which was no doubt expended in pursuance of the policy to place the systems in a perfect condition, in order to be prepared to ward off competition upon the expiration of the fundamental telephone patents. The report refers to the probability of a system of tariff rates being substituted for the present flate rate. That this will eventually be done there is no doubt, as there is neither rhyme nor reason in the present method of fixed charges through which the small user is overcharged and the large user gets his service below cost—an absurd method that is being rapidly discarded in charging for the electric light. The statistics given in regard to the relative use of the telephone in the United States and other countries are gratifying to patriotic pride. It is shown that the United States has more telephones than all of continental Europe, with its more than 300,000,000 inhabitants, and that in commercial England, France and Germany there are 844, 1,583 and 580 inhabitants to a telephone, while in America there is a telephone to every 265 persons, or one to about every 50 voters. The reference to the excellent construction of long distance telephone lines recalls to mind the uniform lack of public recognition given by the American Bell company to the professional talent to which it owes a part of the success which has placed millions in its coffers. Owing to its policy of sinking the personality of its employes it is only within a limited circle that the value of the work of men like Lockwood, Pickernell, Carty and others has become known—a circle to which the splendid technical successes of the company is therefore not a mystery, as it is to the general public.

THE NEW PRACTICAL MAGNETIC UNITS.

In our last issue we referred to the probable application of the practical magnetic units provisionally adopted by the American Institute of Electrical Engineers at its recent meeting, and stated that since names had been given we might expect methods to follow that would cause them to be as readily and simply employed in magnetic calculations as their electric analogues are in electrical calculations. In another column Messrs. Houston and Kennelly point out how this may be done, and after reading their article, many, if not all, the doubts will be removed from the minds of those who had formed their ideas of the practicability of the new units from supposed difficulties in their direct application to practical calculations. Heretofore in magnetic formulas the reluctance has entered as a component part of the entire expression and been thus hidden; or if considered separate, it was in a form similar to that of resistance if instead of substituting its value in ohms we had instead represented it in terms of specific resistance, and length and diameter of conductor. In electrical calculations we now determine the resistance in ohms before substituting it in any practical formula; similarly in magnetic units, since we have given a concrete form to the idea of reluctances, we will now, as a matter of course, calculate its value in oersteds and apply the result in an exactly similar manner to that of resistance in ohms. Much has been said of the impracticability of a unit of magneto-motive force which is not of the same magnitude as an ampere turn, or not related to that magnitude by a power of 10. In the article to which we refer it will be seen that this objection is largely a theoretical one. In the magnetic circuit of a dynamo, for example, having found the value of the field in webers and multiplied that by the oersteds, as determined from the ferric and aeroferric circuits, it will be seen that the labor or liability of error in these passing from the resulting gilberts to ampere turns is negligible. Now that we have the units in a concrete form, it is easy to associate them with the electrical units by analogies. The oersted, for instance, corresponds to resistance, or the ohm, the weber to the flow of current or the ampere, and the gilbert to electromotive force or the volt. There is no direct analogue to the gauss, but we consider the density of current in relation to the heating limit of conductors, as we do the density of magnetic flux with reference to a magnetic material. We say, for instance, that the density of current in an armature wire and in a field wire should not exceed, say, respectively 3,500 amperes and 1,000 amperes per square inch, and similarly we say that the flux intensity in wrought and cast iron should not exceed, say, 15 and 9 kilogausses, respectively, the possession of a unit with a name in the latter instance enabling us to avoid specifying the unit area.

POPULAR ENGINEERING LITERATURE.

Since the advent of several semi-popular professional magazines, and the growth of the demands of editors of literary magazines for popular scientific and engineering writing, there has been a vast amount of pseudo-scientific rubbish unloaded on the unsuspecting public. As the average reader of these articles is supposed to be unable to comprehend the real scientific principles at stake, it is therefore thought necessary to select the merely striking and curious points for their delectation. These are then enlarged upon to an alarming extent, and all sorts of speculations added, until the impression is left upon the minds of the readers that scientists and engineers must be a poor lot indeed to be unable to realize some of the promises thus glibly held out by these writers—who, by the way, are almost always unknown in the scientific or professional circles they purport to represent. It is this class who have made a shibboleth of the phrase "Electricity is yet in its infancy," who picture the modern ocean ship propelled by electricity crossing the ocean in a day, and who, after harping upon the use of electricity for trunk railways, have recently substituted electric air navigation as being less tame. The value of a popular article seems to be considered by these writers as in a direct ratio to the number of sensational statements that it can be made to contain, and they apparently view the public they serve as capable of being gulled to any extent, provided the stuff they write is given a semi-scientific guise. One of their favorite themes is the appalling inefficiency of the steam engine. Elaborate calculations are made to show that the steam engine is a wofully inefficient machine and the implication conveyed that steam engineers are a sorry lot not to apply a remedy. We are also told that there is no reason why heat should not be directly converted into useful energy from coal and that the manner in which we at present waste energy in producing light is little short of criminal. While it is true that from a thermodynamic standpoint the steam engine is inefficient, this follows from a law of nature and not through the neglect of man, and there does not seem to be the slightest probability that we shall ever be able to convert heat into mechanical energy with a greater efficiency than that given by heat engines. Another subject that had a great attraction for these gentlemen was the generation of electricity from water power. The energy of water, they argued, unlike that of coal, is free of cost, and the efficiency of the turbine is eight to ten times as great as that of the steam engine. With these data to start with they revelled in predictions; all domestic operations were to be carried on by electricity, and the farmer would sow, harvest, market and even assist the chemical growth of crops by electricity, and man would become a mere tender of electric buttons. That the development of water power for electric transmission purposes has not brought about the results predicted probably concerns the prophets little, as once that their object is achieved—which seems to be the desire of having their sayings liberally quoted in the newspapers as those of distinguished "scientists" or "engineers"—their energies are directed toward new fields to conquer in a similar manner.

Flywheel Regulation of Water-Power for Electrical Work.

BY WM. PIERSON, JUDSON.

The Electrical World of March 17, 1894, describes the electric plant at Concord, N. H., and says "the idea of using flywheel inertia as a factor in the regulation of water power for electric work is being tried here for the first time with great success."

Flywheel regulation of water power for electrical work has been used for the past six years in one other case, at least, as will appear from the following particulars:

An isolated arc light plant, operated by water power through a large turbine wheel, was installed for New York owners at Oswego, N. Y., about 1886. In January, 1888, the writer was requested to correct some unknown defect in the plant, which caused frequent breaks in the lighting service. These breaks were attributed by the people who installed the plant to the ignorance of the dynamo man, who, like most frail humanity, had enough inherent defects of his own without also bearing those of a machine which he could not control.

Parts of the lamps and switches were burned out daily, and both of the armatures—of which there were two—were frequently absent for repairs. Finally both fields and armature were burned out, and the writer was then called in.

Examination of the conditions showed that all the breaks had been of a character likely to be caused by excessive speed in the waterwheel and consequent excessive E. M. F. in the circuit.

The large turbine wheel which furnished the power for the dynamo also operated various other machines of irregular use, and was governed by the ordinary swinging ball governor, geared to the turbine water gate.

This governor, of course, required several seconds' time in which to move the water gate whenever the wheel varied from its normal speed, and it evidently was not quick enough in its action for the electrical part of the load.

The writer decided that all the troubles had resulted from lack of regulation of speed, and a large flywheel was at once ordered and was set up between the turbine and the dynamo, with the immediate effect of stopping all the difficulties complained of.

Complete Metallic Circuits for Electric Railways.

To the Editor of The Electrical World:

The writer has been very greatly interested in the paper on the "Importance of Complete Metallic Circuit for Electric Railways," read by Mr. J. H. Vail at the Washington Convention. Mr. Vail states that "physical difficulties of operation were developed which warned the experimenters to avoid the 3-wire system in future electrical railway work." The difficulties met were in a set of trials made to effect a saving in copper in installations and the trials were made in 1890.

The writer is at the present time furnishing the power to operate the street railways in Portland, Ore., entirely by the system Mr. Vail decries, and further, has been doing so for the last two years. During this time there has not been an interruption chargeable directly or indirectly to the use of three wires. The results obtained by Mr. Vail by the use of track feeders is attained with the further advantage of a saving of more than one-half the wire needed by his plan.

In answer to a query made by the officials of the company operating the water works in Omaha, as to means used to prevent pitting by electrolysis in Portland, Mr. Smith, the engineer in charge of the Portland plant, wrote that no instance of pitting had occurred.

In view of the successful operation of this plant for two years, the writer would be glad to have Mr. Vail point out the difficulties met that led to the statement taken from his paper.

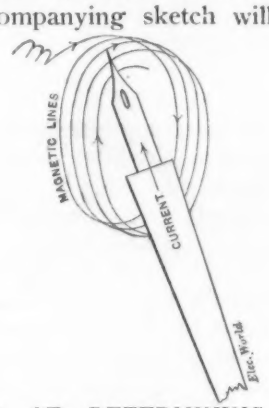
Portland, Ore., March 26, 1894. A. C. BALCH.

An Easily Remembered Rule.

BY CARL HERING.

So many rules have been published giving the relative directions of the current and the lines of force or whirls surrounding it, that it now becomes necessary to apologize for introducing a new one. The apology in this case is the same as the one usually given, that the author believes it to be simpler and more easily remembered than the others. The present rule applies only to the direction of the lines of force encircling the wire and therefore does not refer to the direction of an induced current as in dynamos, or the direction of motion as in motors, for which the writer has found Fleming's well known three finger rule to be the best.

To remember the direction of the magnetic whirls around a current, one has only to remember that if the current flows like the ink from a pen (that is, out at the point), then the direction of the magnetic whirls around this current will be the direction of the circular motion of the whole pen in drawing these whirls as one would, naturally, representing them as a close spiral encircling the pen, and beginning as though one started to write the small letter "m" (magnetic lines). The accompanying sketch will show this more



SIMPLE METHOD OF DETERMINING DIRECTION OF CURRENT.

clearly. Although it takes more than a few words to state this rule it is really simplier than it appears, the only important point to remember being that one must draw the spiral as if starting to write a small letter "m" (magnetism) and not as if starting to write the letter "C" (current); when drawn in the latter direction the current represented by the pen will be the one induced by the generation of these lines, as in transformers.

Some may prefer another rule, which is, that if the direction of the current is the same as the one in which one looks at a watch, then the magnetic lines will have the same direction as the movements of the hands of the watch. The reverse of this also applies: if the direction of looking represents the direction of the lines of force the direction of motion of the hands represents the direction of the current producing these lines.

Electricity in the Courts.

In discussing the legal proceedings regarding Muirhead's condenser, "Industries and Iron" indulges in the following bit of English wit of the "Punch" order: "All the leading electricians are to be in court and will be found on one side of the condenser or the other. The scientific witness—or expert, as he is sometimes called—displays capacity when examined by his own counsel, and resistance when the current is reversed. The judge acts as a condenser, as we have often seen him put a couple of questions so much to the point that there is no possibility of leakage."

On the Applications of the Proposed Names for the Practical Magnetic Units.

BY EDWIN J. HOUSTON AND A. E. KENNELLY.

In close analogy to Ohm's law of electric current flux, namely, $C = E/K$, or amperes = volts divided by ohms, is the law of magnetic flux $\Phi = \mathfrak{F}/\mathfrak{K}$; i. e., webers = gilberts divided by oersteds.

There is this difference, however, that while in a fixed voltaic circuit the resistance of the circuit at any one temperature is independent of the current strength, the reluctance of the iron in a magnetic circuit varies with the amount of flux.

The quantity of fundamental importance in all magnetic circuits is the flux, measured in C. G. S. units or webers. The range of such fluxes in the various forms of magnetic circuit, practically employed, is great. Thus, in the dynamo of largest output yet constructed (the 1,500 kw. intramural multipolar generator at the recent Chicago Exhibition) there were 12 field cores, and consequently 24 separate magnetic circuits through the armature. The flux in each circuit was about 15 megawebers, making the total flux through the armature about 360 megawebers. Again, in the case of an actual generator of 100 kw. capacity, with 8 poles and 16 circuits through the armature, there are at full load 3,538,000 C. G. S. units of flux, or 3.538 megawebers in each circuit, making a total flux usefully employed in the armature of 56.6 megawebers.

Again, the flux in each of the two magnetic circuits through the armature of a continuous current bipolar 1-12-h. p. fan motor is about 40 kilowebers, or 80 kilowebers through the armature in all.

In alternating current transformers the flux also possesses a wide range. A transformer of 100 kw. capacity might have a maximum total flux of 3 megawebers, depending, of course, on the frequency and specifications of design. On the other hand, a small 100-watt transformer operating at 130 ~ might have a total maximum of flux of 160 kilowebers.

In electromagnets there is evidently an enormous range of flux variation, owing to their different cross-sections and in regard to the character of the work they are called upon to perform. A large electromagnet of, say, 100 square centimetres cross-section might have a total flux on closed magnetic circuit of 2 megawebers, while an electric bell magnet having, say, 1 square centimetre of cross-sectional area, might not perhaps develop more than 2 kilowebers of flux.

Flux density, $\mathfrak{B}$, measured in gausses, or webers per normal square centimetre, has been carried experimentally in wrought iron under special conditions by Ewing and Low to 45.35 kilogausses. Practically, however, soft iron becomes saturated in the neighborhood of 19 kilogausses.

In dynamo field frames of wrought iron or soft steel a density of 15 kilogausses is common.

In dynamo field frames of cast iron a density of 10 kilogausses is common.

In alternating transformers worked at frequencies below 100 ~ a density of 9 kilogausses is common.

In alternating transformers worked at frequencies above 100 ~ a density of 5 kilogausses is common.

In the entrefer of dynamo machines a density of 3 kilogausses is common.

In permanent magnets of hard steel a density of 2 kilogausses is common.

The earth's flux in the neighborhood of New York has a density of 0.6 gauss approximately.

The earth's horizontal component has a density of 0.18 gauss approximately.

The reluctance of a magnetic circuit is a very important practical quantity. In closed ferric circuits the reluctance is usually determinable, from experimental data, with all the precision that is necessary for practical work, but in a composite iron and air circuit, for which the name "aeroferric" circuit is proposed, the reluctance, while not so accurately determinable, can yet be approximately computed, when allowance is made for derived leakage paths. To this category all practical motors and dynamos belong. The reluctance of non-ferric circuits is usually very difficult to predetermine, but is also usually of much lesser practical importance.

The reluctance of any homogeneous portion of a magnetic circuit can be expressed in terms of its length, cross-section, and reluctivity, just as the resistance of a voltaic circuit can be expressed in terms of its length, cross-section, and resistivity. The reluctivity of air is unity, or differs from the unity of free ether by an inappreciably small amount. The reluctivity of iron depends upon the flux density, as expressed by the relation

$$\nu = \frac{a}{1 - b\mathfrak{B}^3},*$$

where ν is the reluctivity, while a and b are two constants depending upon the nature of the iron, and determined experimentally from a sample of the iron. Consequently, when the flux density in the various portions of a magnetic circuit are given, the reluctances of those portions are determined, and can then be aggregated like voltaic resistances. The total reluctance in the magnetic circuit or any branch thereof is therefore calculable when due allowance is made for the derived leakage paths, and these latter have lesser influence, the smaller the reluctance of the entrefer.

For example, in the case of the 100-kw. continuous current generator before alluded to, the total reluctance at full load of each separate circuit through the armature is approximately 6 millioersteds, made up as follows:

The armature core reluctance at $\mathfrak{B}$ =	9.5 kilogausses	= 0.20	millioersted
The two entrefer reluctances . . .		= 4.28	" "
The cast steel magnet semi-cores at $\mathfrak{B}$ . . . . =	14.6 "	= 0.78	" "
The cast steel magnet yokes at $\mathfrak{B}$ . . . . . =	13.0 "	= 0.69	" "
Total reluctance		5.95	" "

The allowance for derived leakage paths has here been made in assigning the proper increase of available area, density and reluctivity at that density, to the cores and yoke.

In this instance, about 70 per cent. of the circuited reluctance is situated in the entrefer.

The flux in each armature circuit necessary to generate the full E. M. F. in the loaded generator at speed has been before mentioned to be 3.538 megawebers. Consequently, by Ohm's law, the M. M. F. necessary to produce this flux through the circuit is

$$\mathfrak{F} = \Phi\mathfrak{R}, \text{ or } \mathfrak{F} = 3.538 \times 10^6 \times 5.95 \times 10^{-3},$$
$$= 2.105 \times 10^4,$$
$$= 21{,}050 \text{ gilberts};$$

and since 1 gilbert = 0.7958 ampere-turn—i. e., practically 0.8 ampere-turn, $\mathfrak{F}$ = 16,840 ampere-turns, or 8,420 ampere turns on each field spool. The actual number developed is 8,500 ampere turns at full load, agreeing very fairly with the computed value from reluctance.

The Saline Electric Railway.

The last section of the electric railway to the summit of the Saline, about 5,000 feet above the level of the sea, was recently opened.

*This is a consequence of the known relation $\nu = a + b\mathfrak{B}^c$.

The Portland General Electric Power Plant.

THAT the era of electrical power transmission is fairly at hand is again attested by the magnificent plant now being equipped for the Portland General Electric Company at Oregon City, Ore., twelve miles from the city of Portland, on the Willamette River. So much has been said and written of the possibilities of electrical transmission in the last few years that it is encouraging to see a practical demonstration of this principle on such a scale as is now being executed in the enterprising Northwest. With the Portland General Electric Company it is no longer a question as to whether a plant of this kind will successfully operate. It is now a question of how much time will be necessary to place all the apparatus and turn on the water. As an engineering effort, both from an electrical and mechanical standpoint, this power station is one of the most important yet constructed. The present plant is of thoroughly legitimate parentage. It is the offspring of a somewhat similar plant built several years ago with the crude waterwheels and generators there in service. Notwithstanding this fact the plant has been in successful operation from the very start, and has proved to be a first class investment. Its continued success, its extreme simplicity and exceedingly profitable returns on the investment are jointly responsible for what is to be one of the most complete and interesting electrical power plants ever constructed.

Nature and the State government of Oregon have combined to furnish the Portland General Electric Company an ideal water power for its station. A good idea of its location may be obtained from the map shown in Fig. 1. At this point on the Willamette River, known as Oregon City, are a series of broken falls, over which navigation is impossible. The State government consequently designed a canal along the left bank of the river, through which vessels could pass around the falls and continue their course. The Portland General Electric Company has secured con-

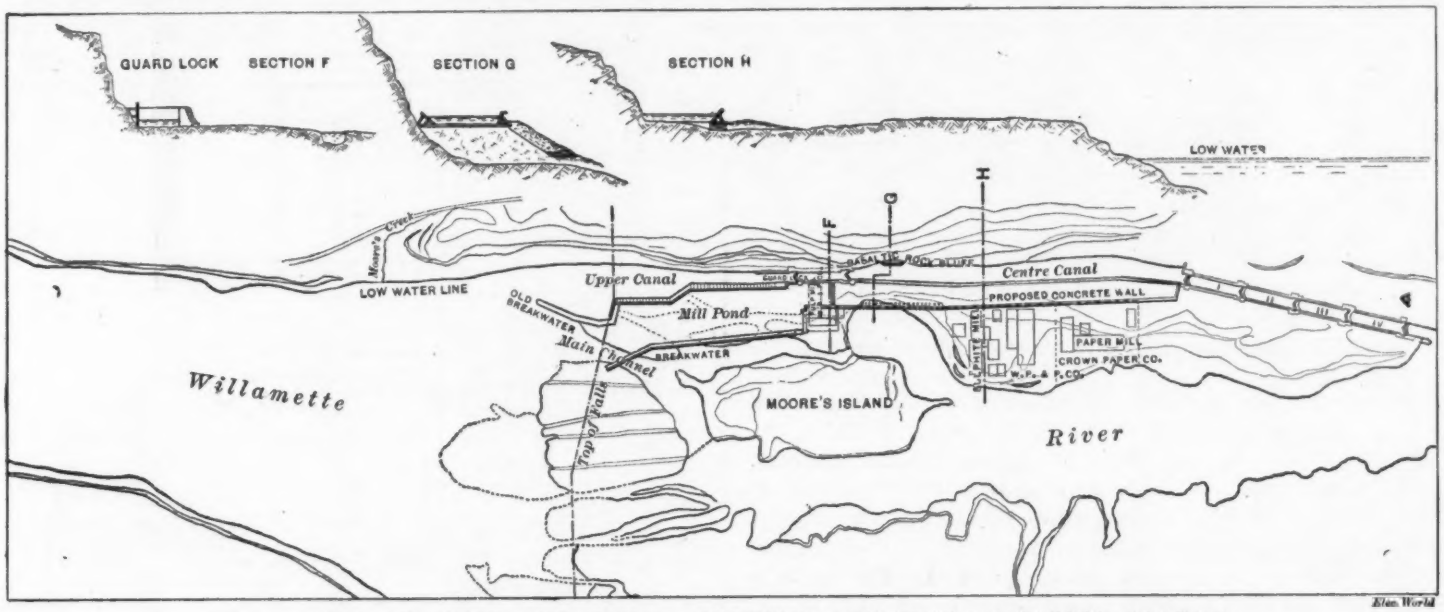


FIG. 1.—MAP OF RIVER AND CANAL, SHOWING LOCATION OF POWER STATION.

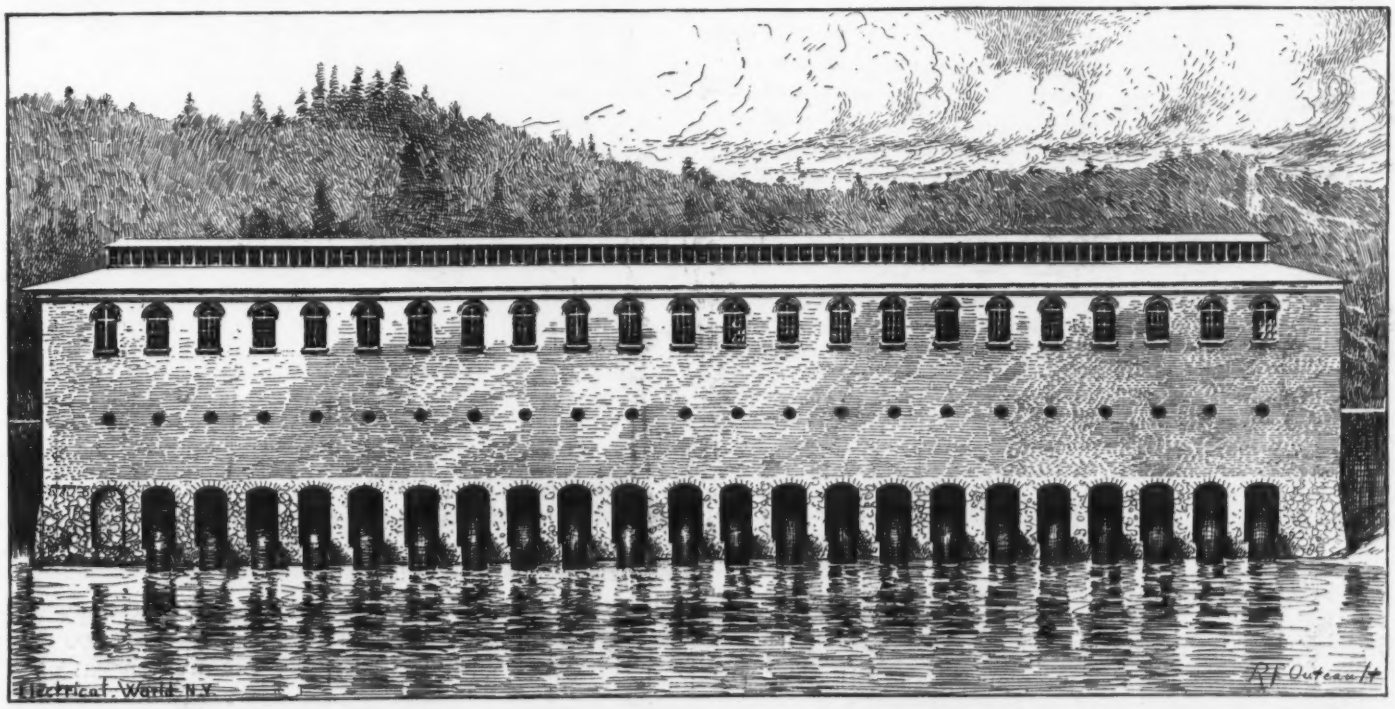


FIG. 2.—EXTERIOR VIEW OF THE POWER STATION.

trol of this canal, and is erecting its new power station at the point marked *G*. The building will form one wall of the canal, and from the gates in this wall the water will pass through the turbines to the draft tubes to the bed of the river below, a fall of 40 feet.

At this place are several industrial plants now being operated by water power direct, so that the new electrical station will afford engineers an excellent idea of the difference between the new and the old way of utilizing water power. Under the old system the raw material had to be shipped to this point and reshipped when finished; whereas, with the electrical plant, the current is generated here and then transmitted over twelve miles of line to the city of Portland, to be utilized there for lighting the city, operating the street railways and for various other uses to which electric power has been adapted.

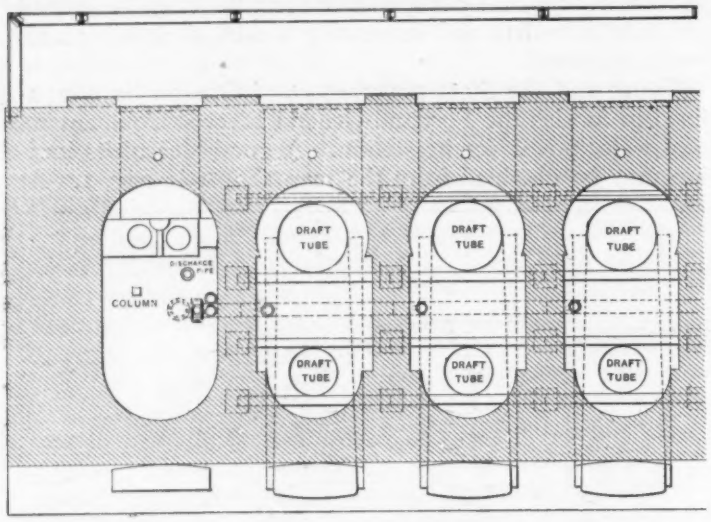


FIG. 3.—SECTIONAL VIEW AT TOP OF TURBINE.

An excellent idea of the exterior appearance of the power station may be obtained from Fig. 2.

It will be noticed that there are *22* sections to the building

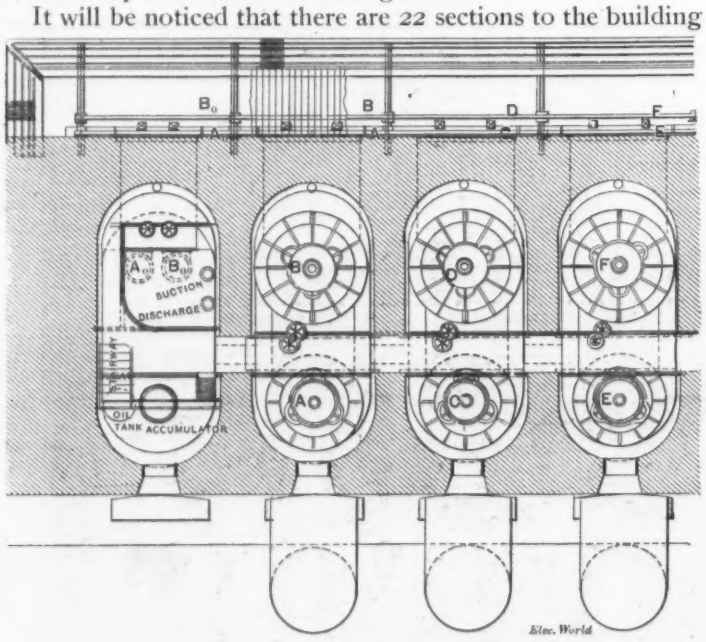


FIG. 4.—SECTIONAL VIEW FROM BULL'S-EYE WINDOW.

of uniform size and style, four of which are shown more in detail in Figs. 3 and 4, which are plans of a short section of the station at an elevation of 30 feet and 48.9 feet respectively. In each of 20 sections are to be installed one 42-inch and one 60-inch cylinder gate Victor turbine, directly connected to a generator of 600 h. p. capacity, making a total electrical equipment of 12,000 h. p. The 42-inch turbines will form the initial plant, while the larger turbines will form the auxiliary plant.

One section is devoted to two 48-inch turbines for driving a pair of exciters of 400 h. p. capacity each, which are directly connected to the shafts of the turbines in the same manner as the generators, making the total electrical capacity of the station 12,800 h. p. One section is devoted to two 15-inch turbines; one for operating a duplex power

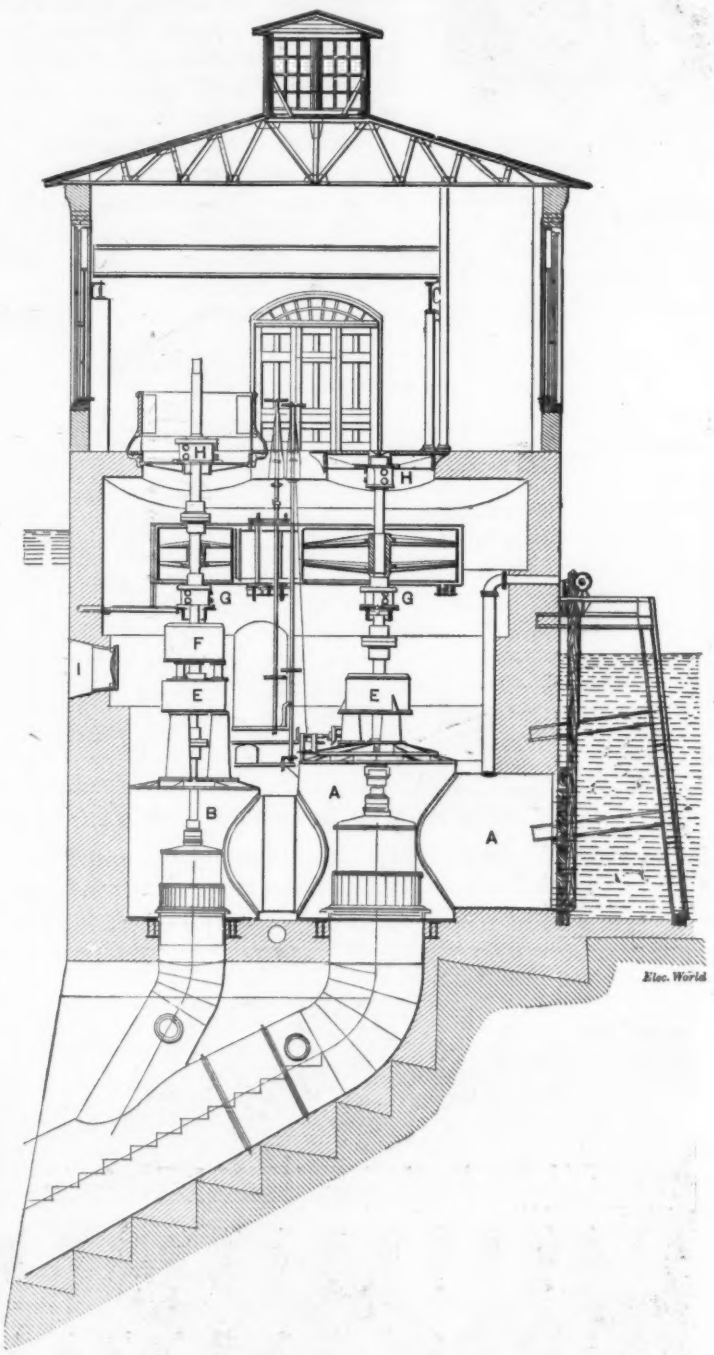


FIG. 5.—SECTIONAL ELEVATION, LOOKING UP-STREAM.

pump that supplies water to the water jackets around the cylinders, and the other for supplying oil to the hydraulic cylinders, as described elsewhere.

It will thus be seen that in one long room there will be electrical generators with a total capacity of 12,800 h. p. divided into *22* separate units, each one independent of the other.

The building itself is of the most substantial character. From the rock foundation to the generator floor it is built of solid cement laid in forms, while from the generator floor to the eaves of the structure is of brick with steel roof. A sectional view is given in Figs. 5 and 6. In this it will be no-

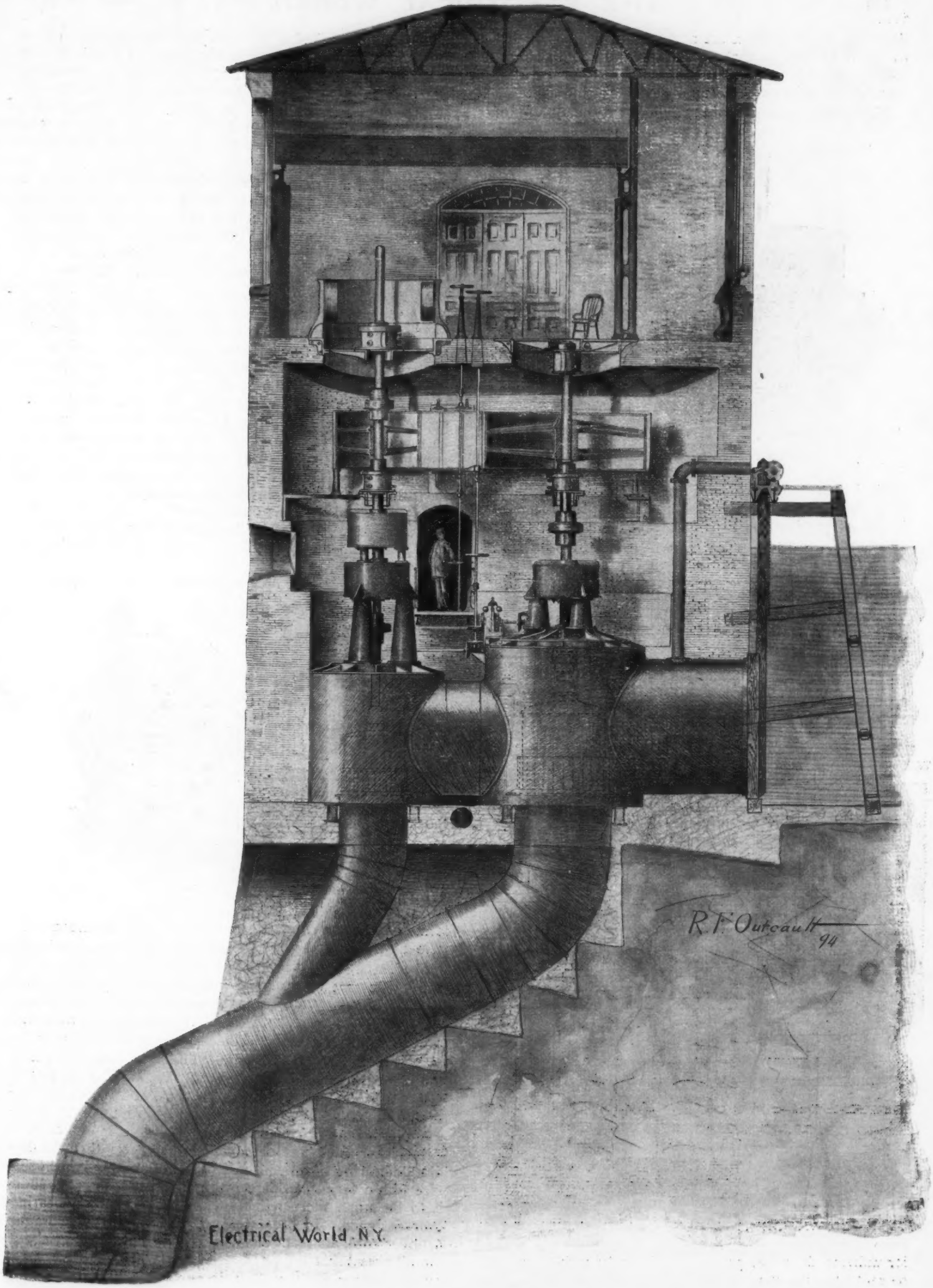


FIG. 6.—SECTIONAL VIEW OF POWER STATION.

ticed that the draft tubes are anchored by a series of shelves to its rocky bed, so that no side pressure could affect the solidity of the structure. It could only be loosened from its foundations by being lifted up out of this anchorage.

Fig. 3 shows a section of the building at the top of flumes,

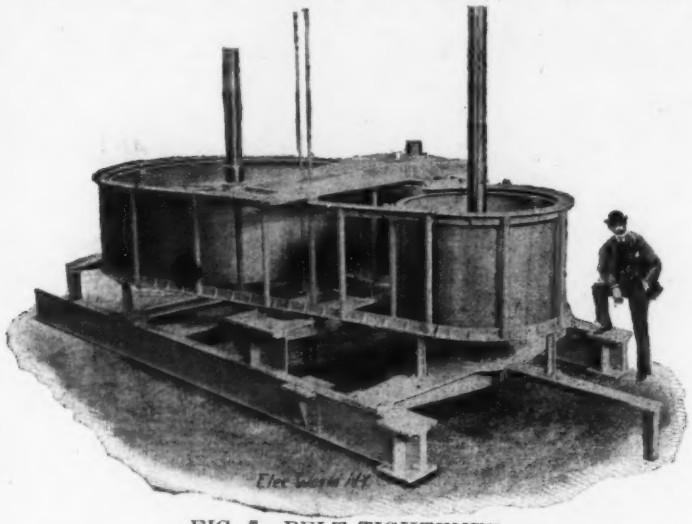


FIG. 7.—BELT TIGHTENER.

while Fig. 4 gives an idea of the structure looking through from the bull's-eye window. The building itself has a total length of 420 feet and is 77 feet from the water level of the river to the eaves.

By following the letters in Fig. 5 the arrangements made

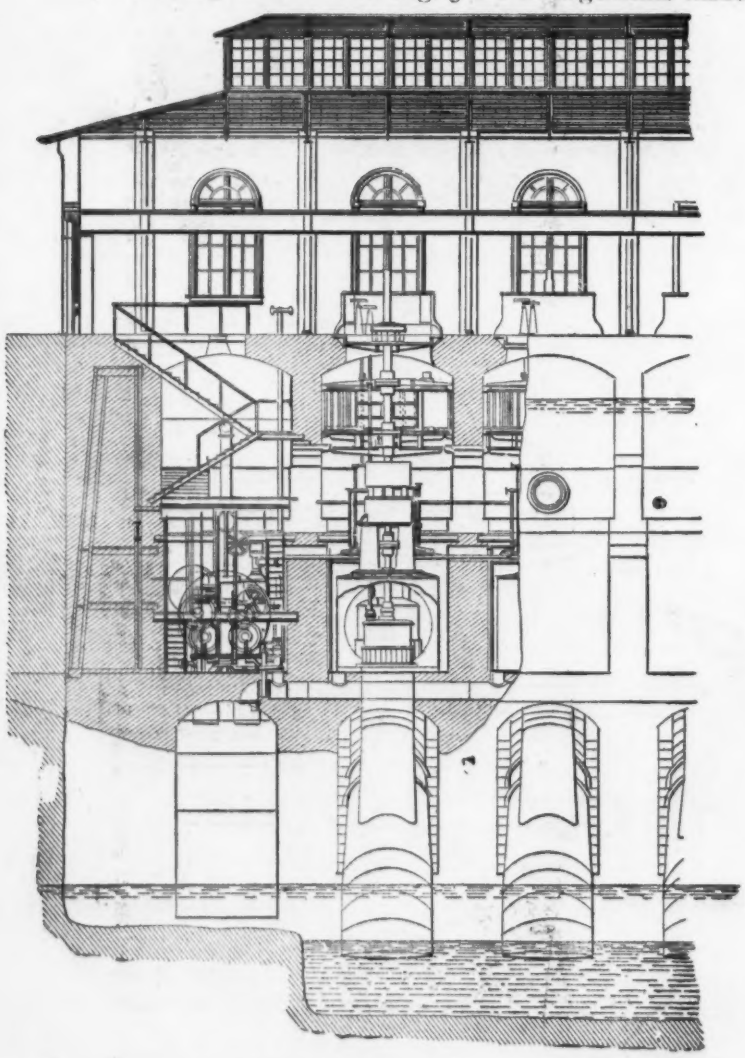


FIG. 8.—LONGITUDINAL SECTION LOOKING UP STEAM.

for utilizing the water power as it flows from the canal may be readily understood.

The flume marked *A* contains a 60-inch turbine, while flume *B* contains the 42-inch or initial turbine that is directly connected to the generator shaft. This latter is the one that will ordinarily carry the load, as it is calculated to operate at a speed of 200 revolutions per minute under a head water of 40 feet. The 60-inch turbine has been installed to take care of the rise of water which occurs in the Willamette River, according to the records, once every five years. In other words, a duplicate turbine equipment is installed to take care of a change in the head water that occurs but once in five years, which shows the thorough and permanent character of the station. In the event that the larger turbine is necessary, the coupling *C* on the generator shaft is disconnected and the larger turbine started. The power is conveyed to the generator shaft by a belt tightener, *D*.

A good view of this tightener is given in Fig. 7. The large pulley is 12 feet in diameter with a 48-inch face, and carries a 46-inch vertical belt. The receiving pulley is 6 feet in diameter. The belt guide, which runs around both pulleys, holds the belt clear from the pulleys when not in use. When the 60-inch turbine is to be used, the hand wheel in the generator room closes the tightener between the two pulleys, so that the belt is drawn tight, and the same power is secured at the generator as if the small turbine were in service.

After passing through the turbines the water discharges into the draft tubes shown in the illustrations. These are so arranged that one outlet is sufficient for the two turbines. This is very clearly illustrated in Fig. 8, which shows one generator section and the pump room looking up stream.

The large draft tube rests on the shelf arrangement, which

FIG. 9.—BULL'S-EYE WINDOW.

forms an anchorage for the entire structure, as already described.

To take care of the great weight of the generator shaft and turbine—33,000 pounds—extraordinary precautions were necessary. The letter *E*, Fig. 8, represents a mechanical thrust bearing, water jacketed, capable of sustaining the entire load; but the hydraulic cylinder, *F*, just above it, is the pivot on which the load usually rests. The oil in this cylinder is kept at a constant pressure of 275 pounds per square inch, and can easily sustain the entire weight of the shaft, both from above and below.

Engineer Rice has demonstrated by tests that the hydraulic bearing of oil will hold this enormous weight in service with a very small percentage of leakage, and tests show it to be much more reliable than any mechanical bearing ever designed. In order to keep the oil in the hydraulic cylinder cool, a stream of water is constantly flowing about the oil chamber.

Still further up the shaft is another bearing *G*, which rests on cast iron beams; but this is relied on more as an

alignment bearing than anything else, and is so protected that no oil from it can flow to the parts beneath.

The letter *I* represents a bull's-eye window arranged in the river wall of the building to admit light and air to the lower sections under ordinary conditions. At times the water of the river backs up to an unusual height, and in this event the window is so arranged that it will admit the light, but not the water.

Another view of this interesting section of the structure is given in Fig. 13. It may be observed that Figs. 5 and 6 show but one of 20 sections exactly similar. Each one is entirely independent of all the others, but it is expected that the current from all the generators will be collected at one switchboard, and from this point transmitted to one main centre of distribution in the city of Portland.

The power in each section is controlled by two hand wheels that can be operated either from the generator or

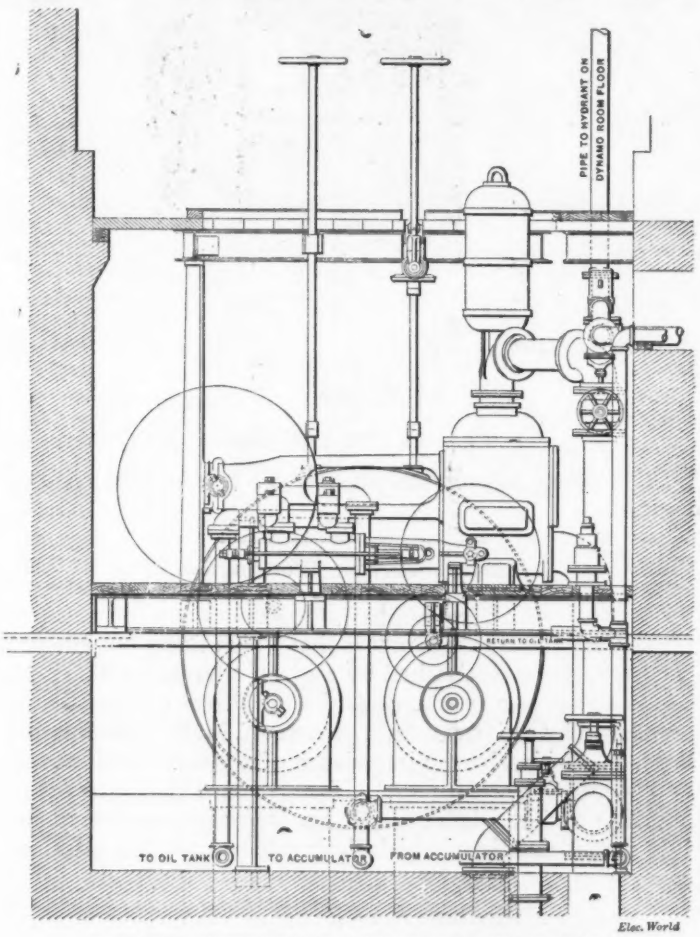


FIG. 10.—SECTIONAL VIEW OF OIL PUMP.

the lower floor, as may be seen in Figs. 5 and 6. One of these wheels serves to start either the 42-inch or the 60-inch turbine, being directly connected to the automatic governor with which these turbines are equipped. This governor is so nicely adjusted as to take care of any variation of pressure on the wheel, and keeps the speed constant. The other hand wheel with one movement brings the tightener in contact and tightens the belt on the pulleys, thereby transmitting the power from the 60-inch turbine to the generator shafts.

The water is admitted to flumes from headgates operated from a platform along the side of the building.

One exciter of 400 h. p. capacity has been determined upon as sufficient for the 20 generators, but two of these are to be installed in order that they will be ready for service with either high or low water. In this section two turbines of equal size are to be installed with no belt arrangement. Instead of the single mechanical bearing supplied to the other auxiliary turbines, the hydraulic bearing is arranged to take care of the weight of the exciter, the same as on the other generator shafts.

One of the most interesting features of the entire plant is the pumping arrangement for supplying oil to the hydraulic cylinders and water to the jackets surrounding them.

Fig. 10 gives a sectional view of the oil pump, while Fig. 11 shows it as it appears. This pump is operated from a separate turbine, as will be noticed in Fig. 11. The oil is

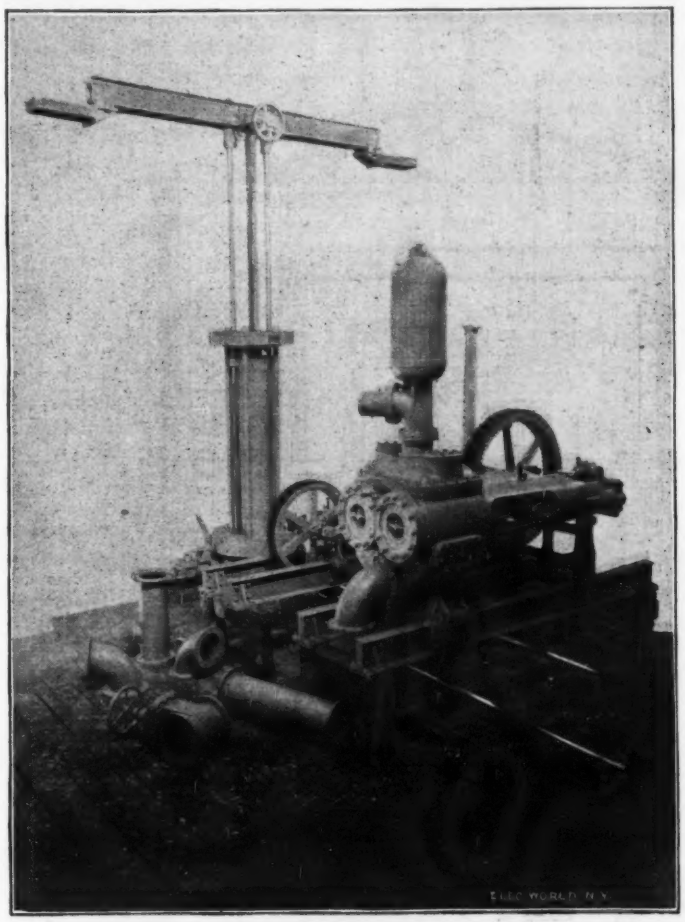


FIG. 11.—OIL PUMP WITH ACCUMULATOR.

pumped into the accumulator shown in Fig. 11. This keeps the pressure of oil at 275 pounds to the square inch when supplying the hydraulic cylinders. The upright shaft with cross-beam is connected to the turbine gate and automatically regulates the supply of oil in the cylinder. That is, if the quantity of oil in the accumulator were to be reduced, the

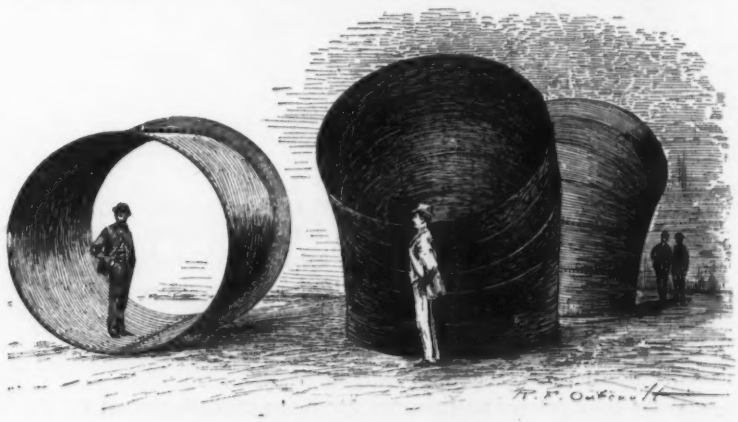


FIG. 12.—DRAFT TUBES.

turbine gates would be opened to a greater angle and more water admitted so as to take care of the additional oil called for.

Another pump is devoted to supplying water to the water jackets around the cylinders. Both are operated by a 15-inch improved cylinder gate Victor turbine.

The generator room is supplied with a 12-ton electric

crane for handling the armatures, etc. This crane has a longitudinal travel of 368 feet, and a cross travel of 24 feet 6 inches.

The switchboard will be placed on the columns which carry the crane.

The turbine used in this installation is what is known as

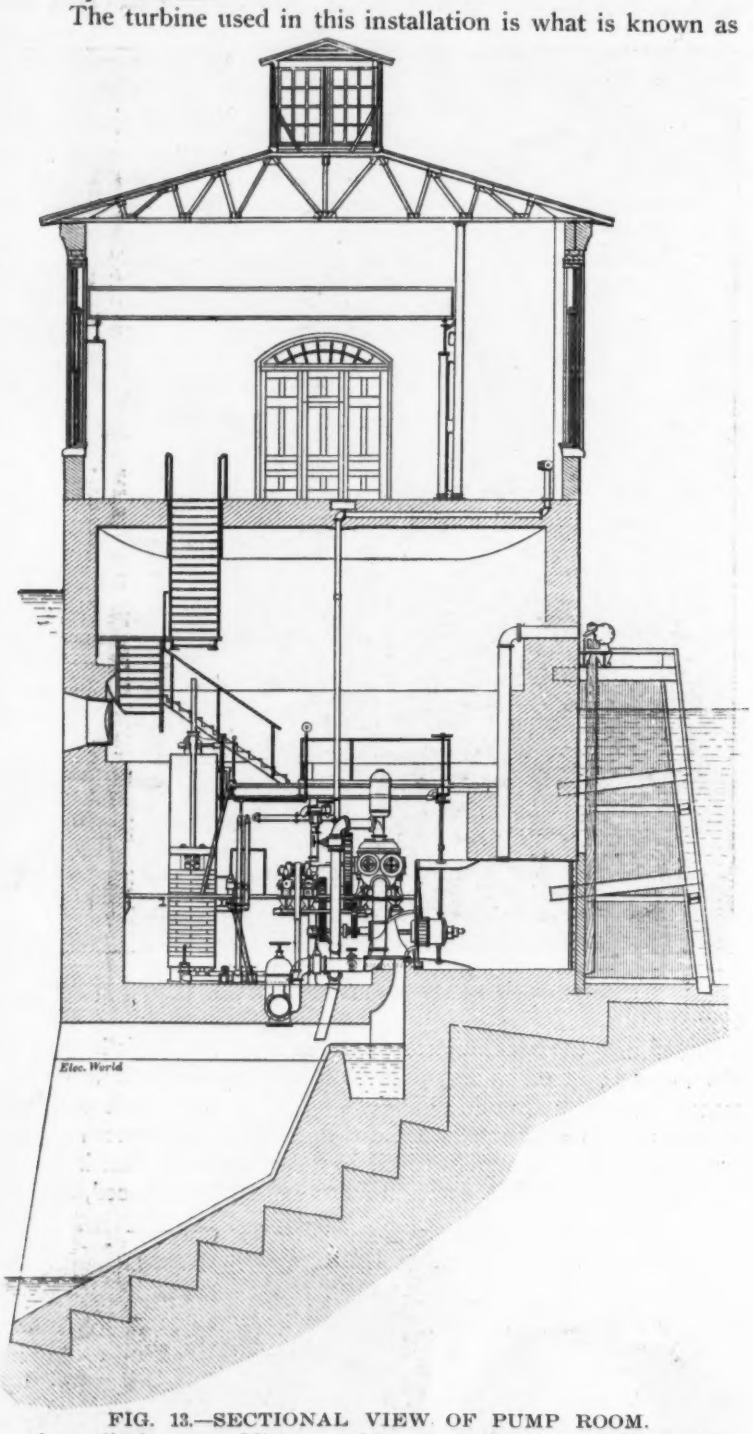


FIG. 13.—SECTIONAL VIEW OF PUMP ROOM.

the cylinder gate Victor turbine, built by Stilwell-Bierce & Smith-Vaile Company, Dayton, Ohio, and designed especially to meet the demand for high partial gate results. Its remarkable steady motion, high speed and great efficiency, together with its close regulation at full and partial gates, recommended its selection for this plant.

The entire power equipment has been manufactured by the Stilwell-Bierce & Smith-Vaile Company at their extensive shops a tDayton, Ohio. All the plans for the development of the entire plant were drawn by their well-known engineer, Mr. A. C. Rice, who has devoted a great deal of time and careful study to this plant.

The electrical part of the equipment is to be supplied by the General Electric Company, and promises to present many new features of interest in three-phase electrical transmission. Mr. P. F. Morey is president of the company,

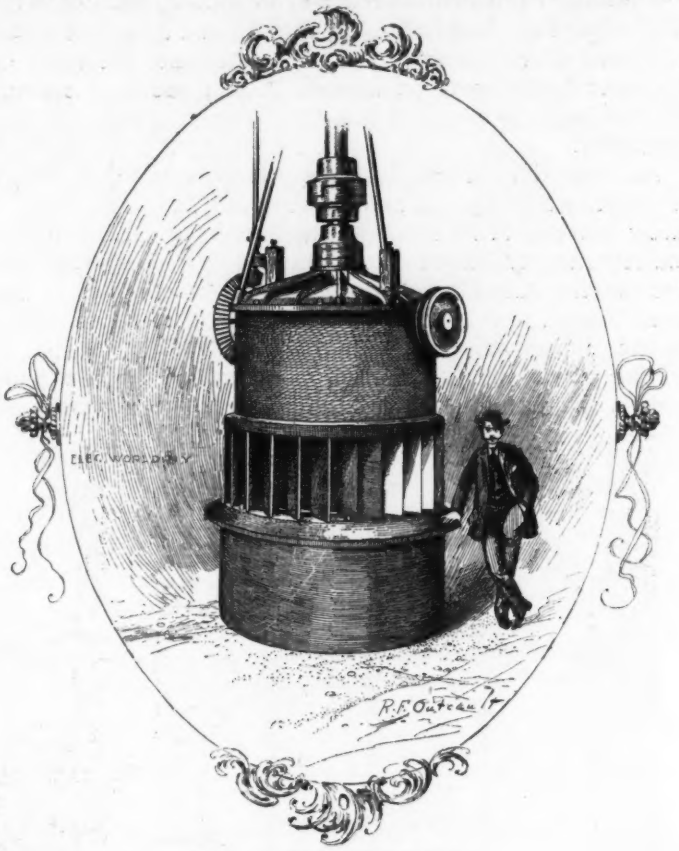


FIG. 14.—THE TURBINE.

W. C. Cheney superintendent, and T. W. Sullivan resident engineer.

Alternate Current Working.—V.

BY HARRIS J. RYAN.

The impedance of a circuit is that which limits the amount of current to be established by a given alternating E. M. F., just as the ohmic resistance limits the direct current that is established by a given amount of direct E. M. F. Alternating E. M. F. divided by the impedance of a given circuit equals the current that will be established. Since the resultant of induction and resistance E. M. Fs. is the hypotenuse of the right angle triangle of which their values form two sides, we have

$$\text{Resultant } E = \sqrt{E_R^2 + E_L^2},$$

$$\text{Impedance} = \frac{E}{C} = \sqrt{\frac{E_R^2}{C^2} + \frac{E_L^2}{C^2}},$$

$$\frac{E_R^2}{C^2} = R^2 \text{ and } E_L = \omega L C, \quad \frac{E_L^2}{C^2} = \frac{\omega^2 L^2 C^2}{C^2} = \omega^2 L^2.$$

Substituting these values, we have

$$\text{Impedance} = \sqrt{R^2 + \omega^2 L^2},$$

$$C = \frac{E}{\text{Impedance.}}$$

Circuits sometimes possess capacity and resistance, or capacity, induction and resistance, and the impedance value for such conditions must also be known. The relation between the E. M. F. to which the terminals of a condenser having a capacity K are subjected and the quantity of electricity stored, Q, is given in the following expression:

$$Q = E K.$$

The current through the condenser at any instant is equal to the rate of change of the quantity of stored electricity. Consequently the difference of potential at the terminals,

of a condenser suffers a rate of change that is proportional to the current through the condenser. It will be remembered that the E. M. F. of induction is proportional to the rate of change of magnetism or current causing the induction. On the other hand, the condenser current is proportional to the rate of change of pressure at its terminals. Perhaps the complete exchange of the laws of variation of the values of

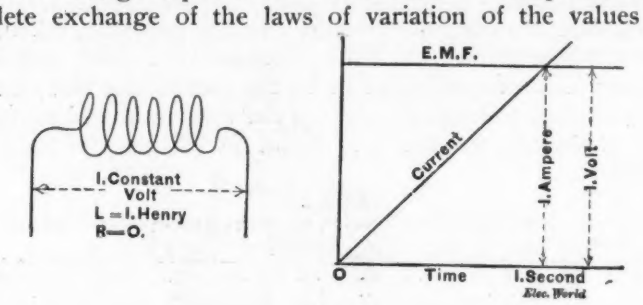


FIG. 14.

current and E. M. F. with respect to time for induction and capacity effects is better seen by a study of Figs. 14 and 15. In the diagram of Fig. 14 the relation between current and the developed E. M. F. is plotted for a circuit having a coefficient of induction of unity or one henry. It is seen that the rate of change of current is one ampere per second and is numerically equal to the developed E. M. F. When the induction and the rate of change of current are not unity the developed E. M. F. equals the product of the rate of change of current into the value of the induction coefficient. The

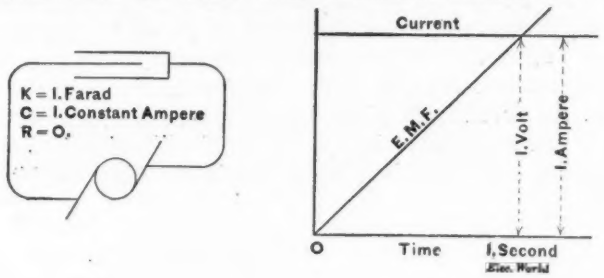


FIG. 15.

diagram of Fig. 15 gives the relation between the current through a condenser and the developed E. M. F. The rate of change of E. M. F. equals the value of the current when the capacity is unity or one farad. For a capacity value other than unity the current is equal to the product of the rate of change of the developed E. M. F. into the value of the capacity.

The outcome for alternating currents of this change of the relations of E. M. F. and current to time in going from induction to capacity effects is illustrated in Figs. 16 and 17. The curves in Fig. 16 are drawn for a circuit having a coefficient of induction of one henry, and those in Fig. 17 for a capacity of one farad. The curves of Fig. 16 are identical with those of Fig. 7 except that the words current and amperes have been substituted for magnetization and lines. It will be remembered that the coefficient of induction is the value with which the current must be multiplied to get a result equal to the product of the turns in the circuit into the number of lines of magnetization established through them. Consequently when the number of turns and the coefficient of induction are each unity the values of the current and magnetization are equal numerically. The current curve in Fig. 16 was, therefore, determined by means of the planimeter in precisely the same manner as the magnetization curve in Fig. 7. The ratio of $E_{max.}$ to $C_{max.}$ when $L = 1$ and $\sim = 1$, is 2π. For capacity effects this relation is inverted; the condenser current is proportional to the rate of change of the E. M. F. that it causes, while the induction E. M. F. is proportional to the rate of change of current that causes it. Accordingly, in determining the relation between the maximum values of the condenser current and E. M. F. for a periodicity and capacity each equal to unity the curve of current is first plotted. The curve of E. M. F. is then determined by plotting as ordinates the areas developed by the current curve or precisely in the same manner as that in which the curves of magnetization were determined for Figs. 6, 7 and 8. The value obtained for the ratio of the maximum current to the maximum E. M. F. is 2π. This, it should be noted, is the inverted relation of induction effects. Since the capacity current is proportional to the rate of change of the E. M. F. it follows that the shorter the period or the greater the periodicity the greater will be the current that a given E. M. F. will establish through a condenser. The capacity current will, therefore, vary as

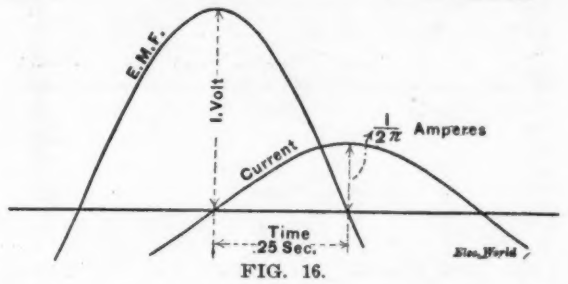


FIG. 16.

the periodicity, capacity, and E. M. F. These properties are given in the following workable expression:

$$C = 2\pi \sim K E,$$
$$C = \omega K E,$$

where K is the capacity in farads.

The capacity current (see Fig. 17) is 90° ahead of the capacity E. M. F., so the E. M. F. that sets it up through the ohmic resistance in the circuit will also be 90° ahead of the capacity E. M. F. The resultant of the two E. M. Fs. is the hypotenuse of a right angle triangle of which they form the sides, or

$$E = \sqrt{E_R^2 + E_K^2},$$

$$\text{Impedance} = \frac{E}{C} = \sqrt{R^2 + \frac{E_K^2}{C^2}} = \sqrt{R^2 + \frac{1}{\omega^2 K^2}}.$$

$$\text{Impedance} = \sqrt{R^2 + \frac{1}{\omega^2 K^2}}.$$

The resultant of E. M. Fs. in a circuit due to ohmic resistance, induction and capacity is the hypotenuse of a right angle triangle, one side of which is the ohmic E. M. F. and the other the difference between the induction and capacity

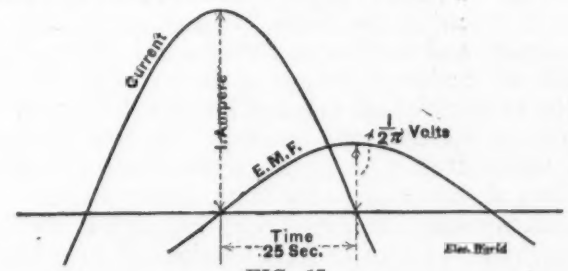


FIG. 17.

E. M. Fs. (see Fig. 18). The expression for the impedance of a circuit possessing resistance, induction and capacity is

$$\text{Impedance} = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega K}\right)^2}.$$

The application of the radial diagrams and the impedance values is illustrated in the following examples.

(To be continued.)

"Industries and Iron's" Opinion of Analogies.

"Analogies are only fit for political speeches and are quite out of place before people of intellect."

Transformation of Alternating Currents.

BY CHARLES PROTEUS STEINMETZ.

With very great interest I have read Mr. Scott's valuable paper on alternating currents, presented to the National Electric Light Convention at Washington.

Having worked myself in this direction, I may add a few remarks, which, while perhaps of lesser interest, may go a step further toward explaining the fundamental principles underlying the transformation of electrical energy.

Let there be drawn, Fig. 1, a sine wave of alternating current, as curve *I*.

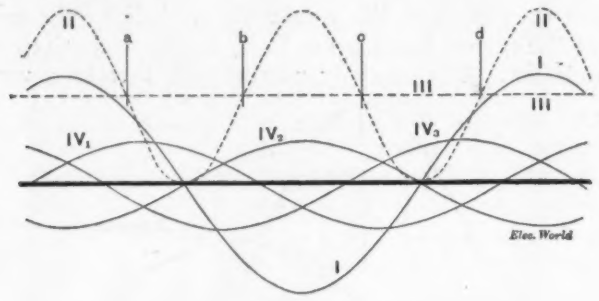


FIG. 1.

Then, the wave of energy transmitted by this current will be a wave of double frequency, as shown in dotted line by curve *II*, if the circuit is non-inductive. If the circuit is inductive, this curve will intersect the zero line, but otherwise have the same character.

Take, however, the waves of the E. M. Fs., or the currents in a balanced polyphase system, as, for instance, a three-phase system. The three waves differ in phase by one-third of a period, and are represented in Fig. 1 by the curves IV_1, IV_2, IV_3. Their curves or waves of energy are three sine waves of double frequency of the same character as curve *II*.

Adding the values of power in the three circuits at any instant gives a constant quantity, as represented by straight line *III*.

The same holds for any balanced polyphase system.

We get thus: "The flow of energy in a balanced polyphase system, as well as in a continuous current system, is constant, while the flow of energy in a single-phase alternating current system is fluctuating with a frequency twice the frequency of the E. M. Fs."

The consequence hereof is, as I have shown in the discussion of Lieut. Patten's paper ("Transactions of American Institute of Electrical Engineers," 1892, page 92), that polyphase currents and continuous currents can be transformed into each other without storage of energy, while the transformation of single-phase currents into continuous currents or polyphase currents and inversely requires storage of energy, which cannot be gotten economically by electro-magnetism, since the efficiency of an electro-magneto electric transformation of energy is very low, due to the losses of energy by hysteresis (see "Transactions of American Institute," 1892, page 746).

This constancy of the flow of energy in all the polyphase systems is their foremost and perhaps only advantage over the single-phase system, by enabling their mutual transformation without storage of energy.

Thus, as I stated last summer before the International Electrical Congress at Chicago (in the discussion of power transmission before section C)—

"Any polyphase system can be transformed into any other polyphase system by means of two stationary transformers only."

Some numerical data on such a transformation between quarter-phase and three-phase circuits, taken from a set of tests, which I made some time ago, may be of some interest in showing the complete balance and the high efficiency which can be reached, an efficiency indeed as high as in the transformation from one system into the same system.

The tests were made with a frequency of 33 cycles, and at the quarter-phase side the voltage was kept constant at 100 volts per phase.

The first two columns give the amperes per phase on the quarter-phase side at 100 volts impressed; the third, fourth and fifth columns the amperes on the three-phase side; the sixth, seventh and eighth columns the volts measured at the three-phase side, and the last column the efficiency of transformation.

TABLE I.

Quarter phase—Three Phase Transformation, 33 cycles; 100 volts per phase primary

Primary, —Quarter phase—		——Secondary, Three phase——						Output.	Efficiency
C_1.	C_2.	C_1.	C_2.	C_3.	V_1.	V_2.	V_3.	W.	per cent.
....	....	....	....	....	114	114	115	....	....
9	8.5	5	5.5	5	111	111	112	1,025	58.5
12	11.7	11	11	11.7	108	108	109	2,380	96.1
17.5	17	16.5	16.5	15.5	105	105.5	106	3,190	92.5
20.5	20	18.5	19	19.5	103	103	104	3,670	90.5
31	28	27	30.6	30.6	98	97	97.5	5,360	90.9

As seen, the efficiency reaches 96.1 per cent., and then gradually drops off, due to the increasing $C^2 R$ loss in the transformers, which were greatly overloaded in the last readings, their total capacity being about 2,000 watts.

Referring now to the design of the transformers for changing the system, we shall proceed in the following way:

As has been shown elsewhere, for alternating E. M. Fs., currents and magneto-motive forces, the law of parallelograms holds.

If now we have two magnetic circuits, as transformers, carrying magnetic fluxes displaced in phase by any angle, say 90 degrees, these magnetic fluxes may be produced by exciting the primary coils of the transformers by means of two M. M. Fs. differing in phase by the same angle, and will induce in the secondary circuits E. M. Fs. differing by 90 degrees also, which can be represented in the diagram, Fig. 2,

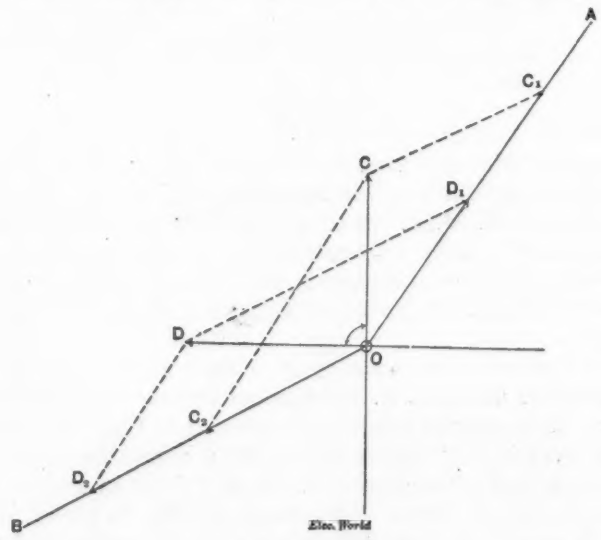


FIG. 2.

by directions *O C* and *O D*. It is not even necessary that the two fluxes have the same intensity, but they may be different; for instance, the second may be one-third the intensity of the first.

It is simple now to get by the combinations of E. M. Fs. of these two directions; that is, by connecting in series the proper numbers of turns of both transformers, resultant E. M. Fs. in any desired phase or phase relation; for instance, two E. M. Fs. of equal intensity differing in phase by 135 degrees, as represented in the diagram, Fig. 2, by *O A* and *O B*.

Thus, if *O C* is the secondary E. M. F. desired in one transformer produced by 100 turns and *O D* the secondary

E. M. F. of the other transformer, of equal intensity, hence produced by 300 turns (since the flux in the second transformer is only 1-3), and the two primary E. M. Fs. are equal but differing in phase by 135 degrees, as represented by $O\,A$ and $O\,B$, we have to complete the parallelograms $O\,C^{\rm I}$, $C\,C^{\rm II}$ and $O\,D^{\rm I}$, $D\,D^{\rm II}$, and get

$$O\,C^{\rm I} = 52 \text{ turns},$$
$$O\,C^{\rm II} = 30 \text{ turns},$$

as the two components of $O\,C$;

$$O\,D^{\rm I} = 90 \text{ turns},$$
$$O\,D^{\rm II} = 150 \text{ turns},$$

the components of $O\,D$.

Hence, the first transformer will contain 52 turns of the first and 30 turns of the second phase as primary and 100 turns as secondary, and the second transformer will contain 90 turns of the first and 156 turns of the second phase as primaries and 300 turns as secondaries. By connecting the primary turns of the same phase in series we get from two equal primary E. M. Fs. differing in phase by 135 degrees two equal secondary E. M. Fs. differing in phase by 90 degrees.

It is obvious now that an infinite variety of combinations can be chosen to produce one polyphase system from another, but the general way will be to choose two directions, as the directions of the magnetic flux or the induced E. M. Fs., and to dissolve the primary and secondary E. M. Fs. by the law of parallelograms into components in the directions of the two induced E. M. Fs., and choose then the number of primary and secondary turns in proportion to these components.

Obviously, it is left to the skill of the designer to choose the directions of the magnetic fluxes so as to produce the desired phase with minimum number of turns, that is, minimum expenditure of copper and of energy. When dealing with larger units, the total efficiency and weight efficiency are occasionally found higher by choosing three transformer units, carrying fluxes displaced in phase by 120 degrees.

In general, however, I think it is now the custom to use in the transformations of polyphase systems, especially three-phase systems, two transformers only, and the use of three transformers has become antiquated, except in cases where the third transformer takes the place of a reserve, which enables us to maintain the service of a balanced three-phase system, even if one of the transformers should give out.

There is, however, one restriction to be made, which reduces the practical value of any method of transforming from system to system by stationary transformers. This is, the flow of energy in the secondary circuit is the same as the flow of energy in the primary circuit, and consequently if the secondary circuit is unbalanced by an unequal distribution of load, and thereby gives a fluctuating power curve, the primary circuit becomes unbalanced also, and no matter what system is used will give the same fluctuations of the flow of energy, so that the liability of polyphase systems to get unbalanced by unequal distribution cannot be overcome by any change of system, but has to be reduced to insignificance by a proper arrangement and choice of the constants of the system.

Furthermore, it is to be considered that anything that can be done in electrical distribution by one polyphase system can be done by any other polyphase system also. and most of it by a single-phase system, so that there exists in these days no good reason for using polyphase systems for electrical light and power *distribution* in place of the low-frequency, single-phase system, which by its simplicity and ease of regulation is far superior to any polyphase system.

Thus, the only proper sphere for polyphase systems is the high potential line of long distance power *transmission*, where the three-phase system offers the advantage of the saving of copper of 25 per cent. over the ordinary alternating current system, or even a larger saving, if the line is redesigned for the most economical conditions, as has been pointed out, I believe, by Prof. Forbes and mentioned by Mr. Scott in his paper.

Even in such a long distance transmission, in the receiving circuit the distribution will take place by splitting up the polyphase system into its component single-phase systems, hence by a modified single-phase system.

Coming now to the question of the transformation of the period, that is, the change of frequency by transformation, the following considerations will lead us to the solution of the problem.

Suppose in an alternating polyphase transformer the primary circuits of different phases are arranged so as to give a rotating field instead of an alternating. Then, in a stationary secondary circuit in this rotating field, the E. M. F. induced is of the same frequency N as the primary frequency. If, however, the secondary circuit rotates with a speed corresponding to the frequency $N^{\rm I}$, then the secondary conductor will cut the lines of the rotating field at the rate of $S = N - N^{\rm I}$ or $S = N + N^{\rm I}$, according to the direction of rotation.

Thus, the frequency of the secondary E. M. F. will be $S = N \pm N^{\rm I}$, if N is the frequency of the primary current and $N^{\rm I}$ the frequency of rotation of the armature.

Neglecting losses the secondary power will have to the primary the ratio $\frac{S}{N}$, hence will be less than primary power if the secondary rotates in the direction of the rotating field, more if it rotates in the opposite direction.

In the first case mechanical energy is given off by the revolving secondary, which may be taken up by an alternating generator and returned to the circuit. In the second case, mechanical energy is consumed and may be supplied by an alternating motor from the circuit.

This transformation has the disadvantage of requiring revolving mechanism, but has the advantage of efficient storage of energy by mechanical momentum, hence it is independent of the balance of the circuits in the polyphase systems, and can be used also for transforming from and to single-phase currents.

A number of tests I made some time ago on this transformation of frequency gave, amongst others, the following results:

TABLE II.—TRANSFORMATION OF FREQUENCY.

Frequency of primary circuit. N	Frequency of rotation. N_1	Frequency of secondary circuit. S	Input Watts. Electrical. W	Input Watts. Mechanical. W_1	Input Watts. Total. W_0	Output, watts. W_1	Per cent., efficiency.	System. Primary.	System. Secondary.
24.6	34.3	58.9	3,120	4,590	7,710	5,300	69	three-phase.	three-phase.
25.0	35.0	60.0	2,310	2,300	4,610	3,230	70	three-phase.	single-phase.

Incandescent Wiring Specifications.

The Montreal Electric Club has submitted to the architects of Montreal for adoption a set of specifications for concealed incandescent wiring as follows:

1. All wire used must be rubber covered and equal to either Habirshaw, Grimshaw or Bishop.

2. No gauge smaller than No. 16 B. & S. shall be allowed to be used.

3. Wire for — volt current, on two-wire principle, loss not to exceed 2 per cent.

4. All joints to be well made and properly soldered and shellaced, covered with a layer of rubber tape, also with an outer covering of good black friction tape.

5. Place necessary cut-outs as required by Board of Fire Underwriters' rules, the same to be on slate or porcelain bases and double pole.

6. Where wires pass through walls and floors they are to be protected by an extra covering in the shape of a durable and moisture proof insulating material, excepting soft rubber tubing, equal in thickness to the insulation on the wire.

7. Where wires run along ceilings and walls, they must be kept at least 2 1-2 inches apart; where passing through holes in the walls and flooring, each wire must have a distinct hole for itself.

8. All speaking tubes, gas pipes and metallic substances of like nature are to be avoided, but where it is necessary to cross same, the wires must be bridged over with wood or hard rubber tubing. If the pipe is for hot water or steam, an air space of at least 4 inches is to be allowed between wires and pipes. All wires crossing water pipes should pass over said pipes if possible or be protected from drip.

9. Outlets for single-pole switches may be left where there are not more than 8 amperes to be controlled; where there are more than this quantity, the outlets must be arranged for doubled-poled switches.

10. No staples or metallic fastenings will be allowed for holding wires in place.

11. Outlets must be taped when passing through plaster.

On Certain New Prefixes Proposed for Physical Unit Magnitudes.

BY EDWIN J. HOUSTON, PH.D., AND A. E. KENNELLY, F. R. A. S.

The increasing extent to which scientific unit magnitudes are being used in physical research has received a check by the inconvenient size of some of the fundamental C. G. S. units, particularly the dyne and the erg.

In order to lessen this inconvenience, we would propose the following additional prefixes, which we have found convenient in our own work.

For example, instead of writing "one thousand megergs" we would suggest the term "one begerg"; and, similarly, for the expression "one million megergs," the term "tregerg," and for a "billion megergs" a "quegerg," following the analogy presented by the words million, billion, trillion and quadrillion.

Again, instead of writing "the one thousandth of a microfarad," we would suggest the use of the term "bicrofarad," and also the tricofarad as the millionth of a microfarad where necessary.

The meaning of these suggested prefixes is, therefore, as follows:

Bega = 1,000 million, or a billion, or 10^9.
Trega = one million million, or a trillion, or 10^{12}.
Quega = 1,000 trillion, or a quadrillion, or 10^{15}.
Bicro = 1,000 millionth, or 10^{-9}.
Tricro = one trillionth, or 10^{-12}.

The following applications of these prefixes will suggest their advantages.

From 1 metre = 1. metre = 100. cms.,
and 1 mm. = 0.001 metre = 0.1 cm.,
and 1 micro-metre = 1. micron = 0.000,001 metre
= 10^{-6} metre = 10^{-4} cm.,
1 bicro-metre = 1 bicron = 0.000,000,001 metre = 10^{-9} metre = 10^{-7} cm.,
1 tricro-metre = 1 tricron = 0.000,000,000,001 metre = 10^{-12} metre = 10^{-10} cm.

The micron is of the order of the length of a light wave in the ether, and is a fundamental unit of magnitude in microscopy.

The bicron is a magnitude which will be useful in dealing with the mean free path of gaseous molecules, according to the kinetic theory of gases.

The tricron is of the order of molecular dimensions, according to the estimate of Kelvin.

From 1 megadyne = 10^6 dynes = approximately the earth's gravitational force on one kilogram of matter.

One begadyne = 10^9 dynes = roughly the earth's force on one ton of matter, *i. e.*, the weight of one ton.

One tregadyne = 10^{12} dynes = roughly the weight of 1,000 tons.

1 megarg = 10^6 ergs = 0.0737 foot-pound at Greenwich.
1 begerg = 10^9 ergs = 73.7 foot-pounds at Greenwich.
1 tregerg = 10^{12} ergs = 73,730 foot-pounds at Greenwich = 37 foot-tons approximately.

From 1 megohm = 10^6 ohms.
1 begohm = 10^9 ohms = 1,000 megohms.
1 tregohm = 10^{12} ohms = 1,000,000 megohms.
1 quegohm = 10^{15} ohms = 1,000 tregohms.

A begohm is about the insulation of one mile of well insulated conductor.

A tregohm is about the resistance required to limit the deflection of a high grade mirror galvanometer under one volt to one scale division of one millimetre at one metre range. Such a galvanometer might be called a tregohm galvonometer.

A quegohm is the limiting resistance with one volt and unit deflection of an extremely sensitive mirror galvanometer, which might be termed a quegohm galvanometer.

From 1 microfarad = 10^{-6} farad.
1 bicrofarad = 10^{-9} farad, or 1/1,000 microfarad.

The C. G. S. electromagnetic unity of capacity being 10^9 farads is consequently a begafarad. The use of these prefixes, therefore, assigns a convenient name to the C. G. S. unit of capacity, which would otherwise require a special denomination.

From 1 henry = 10^9 cms.
and 1 microhenry = 10^3 cms.
1 bicrohenry = 1 cm.

Laboratory of Houston and Kennelly, Philadelphia, March 29, 1894.

Moonlight Tables for May, 1894.

Herewith we give Mr. H. W. Frund's tables of lighting hours for the month of May under his modified form of moonlight schedule.

TABLE NO. 1. Standard Moonlight System.

Date.	Light.	Date.	Exting.
1	7.20P. M.	2	4.00 A. M.
2	7.20 "	3	4.00 "
3	7.30 "	4	4.00 "
4	7.30 "	5	4.00 "
5	7.30 "	6	4.00 "
6	7.30 "	7	3.50 "
7	7.30 "	8	3.50 "
8	7.30 "	9	3.50 "
9	7.30 "	10	3.50 "
10	11.10 "	11	3.50 "
11	11.50 "	12	3.50 "
12			
13	12.20A. M.	13	3.50 A. M.
14	12.50 "	14	3.50 "
15	1.10 "	15	3.50 "
16	1.40 "	16	3.50 "
17	2.20 "	17	3.40 "
18	No Light.	18	No Light.
19	"	19	"
20	7.40 P. M.	20	9.40 P. M.
21	7.40 "	21	10.40 "
22	7.40 "	22	11.30 "
23	7.40 "	24	12.10 A. M.
24	7.50 "	25	12.50 "
25	7.50 "	26	1.20 "
26	7.50 "	27	1.40 "
27	7.50 "	28	2.00 "
28	7.50 "	29	2.20 "
29	7.50 "	30	2.50 "
30	7.50 "	31	3.10 "
31	7.50 "	1	3.30 "
Total hours, 170.10			

TABLE NO. 2. Frund's New Moonlight System.

Date.	Light.	Date.	Exting.
1	7.20 P. M.	2	4.00 A. M.
2	7.20 "	3	4.00 "
3	7.30 "	4	4.00 "
4	7.30 "	5	4.00 "
5	7.30 "	6	4.00 "
6	7.30 "	7	3.50 "
7	7.30 "	8	3.50 "
8	7.30 "	9	3.50 "
9	7.30 "	10	3.50 "
10	7.30 "	11	3.50 "
11	7.30 "	12	3.50 "
12	7.40 "	13	3.50 "
13	7.40 "	13	12 M.
14	12.50 A. M.	14	3.50 A. M.
14	7.40 P. M.	14	12 M.
15	1.10 A. M.	15	3.50 A. M.
15	7.40 P. M.	15	12 M.
16	7.40 "	16	12 "
17	7.40 "	17	12 "
18	7.40 "	18	12 "
19	7.40 "	19	12 "
20	7.40 "	20	12 "
21	7.40 "	21	12 "
22	7.40 "	22	12 "
23	7.40 "	23	12 "
24	7.50 "	25	12.50 A. M.
25	7.50 "	26	1.20 "
26	7.50 "	27	1.40 "
27	7.50 "	28	2.00 "
28	7.50 "	29	2.20 "
29	7.50 "	30	2.50 "
30	7.50 "	31	3.10 "
31	7.50 "	1	3.30 "
Total hours, 215.40.			

Note.—These schedules are made up on sun time. Where standard time is used and it varies considerably from sun time, the proper deduction or addition must be made to all the times here given.

THE ELECTRICAL WORLD'S DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

COMPILED FROM THE PRINCIPAL FOREIGN ELECTRICAL JOURNALS. BY CARL HERING.

NOTE.—*Owing to the crowded condition of this department the following changes will be made, the object being to enable more space and attention to be given to abstracts of articles and papers of a more important nature. Almost every issue of each of the foreign journals contains descriptions and data, often with illustrations and tables, of local central stations and isolated plants; unless they appear to be of special interest they will not be noticed hereafter. References to descriptions of steam and gas engines, boilers, fuels, etc., and all other subjects not belonging under the heading of electricity and magnetism, will in general be omitted. The Swiss monthly "Journal Telegraphique" (in the French language) contains probably the best telegraph and telephone statistics of the world, and as this Journal is doubtless accessible to those specially interested in this subject, references to such statistics and descriptions in that Journal will hereafter be omitted. Serials in the nature of a treatise on a subject will be noticed only once; this will apply also to papers which are continued in several issues and which are merely referred to in these columns as distinguished from being abstracted. When the same paper or article is reprinted or abstracted in several journals, only the first appearance will be noticed, except if the original is in a foreign language and the reprint is an English translation, in which case the references to the translation will also be given, as usual. Very good abstracts, generally longer than can be given here, are published in the monthly journal of the Institution of Electrical Engineers (London), and in the Proceedings of the Institution of Civil Engineers (London), which abstracts will be noticed only in case the original article has not been mentioned in these columns.—C. H.*

ELECTRO-PHYSICS.

Point of Application of Electromagnetic Forces.—"L'Ind. Elec.," March 10, reprints a Physical Society paper by Mr. Pellat on this subject, in which he explains the fact that the work of electromagnetic forces is zero.

Apparatus for Demonstrating Ampere's Law.—"L'Elec.," March 10, reprints from a German paper an illustrated description of a lecture apparatus, devised by Dr. Raps, in which no mercury is required, the contacts being sliding contacts, and the apparatus itself being very large.

MAGNETISM.

Intense Magnetic Fields.—In a recent paper by Du Bois from "Wied. Ann.," mentioned in the Lond. "Elec.," March 16, he states having obtained a field of 38,000 C. G. S. units (gausses) in an air space of several millimetres, and an induction in iron of 60,000, which is believed to be the highest value yet observed.

Magnetarium.—In a Physical Society paper abstracted in the Lond. "Elec. Eng.," March 16, Mr. Wilde describes a hollow geographical globe wound over the whole surface with insulated wire parallel to the equator, and containing within another similar sphere inclined at 23 1-2 degrees; by revolving this at different rates and sending currents through the wires the magnetic conditions of the earth can be imitated, both as regards distributions and secular variations.

Magnetization of Soft Iron.—Mr. Joubin's Academy paper is abstracted in "La Lum. Elec.," March 10; he verifies experimentally the conclusions made in a previous paper regarding the characteristic equation of the intensity of magnetization as a function of the susceptibility.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Phase Meters.—In the first part of an article by Mr. Hess in "La Lum. Elec.," March 10, he describes and illustrates a number of devices (all of which have been described in these columns) for measuring the difference of phase, special attention being given to that of Mr. Claude (described in the Digest April 22, 1893). He calls attention to the importance of making this measurement, as it enters in the calculation of the energy just as the voltage and the current do; the importance of this factor was not appreciated until quite recently. He describes an experimental verification of the fact that the phase difference varies with the frequency, the contrary having been assumed in explaining the existence of a phenomenon analogous to magnetic hysteresis. The usual synchronizing indicator may be easily adapted to measure differences of phase by connecting the secondary to a voltmeter, from the reading of which the difference of phase can be calculated; for small differences the two primaries had better be connected so that the resulting field is the addition of the two components and is then proportional to the cosine of half the angle of lag; the third winding and the voltmeter are not required if one measures the amplitude of the resulting magnetic field by the rise of temperature due to the Foucault currents, as was suggested by Mr. Claude.

Hysteresis Testing.—Mr. Parsons, in the Lond "Elec. Eng.," March 16, describes a simple method used by his firm for comparing different samples of iron; two identical solenoids are coupled in series and into each is put a core of a definite weight of iron plates insulated with paper and having in the centre a piece of wood with a slot for a thermometer; one of these cores is considered a standard and the other is compared with it by the reading of the thermometers; the induction can be varied by the E. M. F. or by the weight of the cores. He thinks that there is no advantage in annealing the plates, but that they should be insulated from each other.

Rapid Verification of Meters.—In an article abstracted in in "L'Ind. Elec.," March 10, Mr. Picou points out how each of the more common meters may be verified by passing a constant, measured, current through them and observing the time of certain cycles from which, knowing the construction of the meter, the calibration may be made in a very short time; for the Thomson meter all that is necessary is to count the number of revolutions in a given time, knowing that 100 turns correspond to one division. Some such method, he says, is applicable to most meters. (It would have to be repeated, however, for different currents, as a meter may be correct for one current and not for another.)

Electro-Dynamometer.—The Lond. "Elec. Rev.," March 16, gives an illustrated description of the Giltay electrodynamometer based on the principle of Bellatti, the theory being the same as that of Weber's; the improvement consists in the formation of an astatic system composed of two equal bundles of wires moving in two different coils, so that the dsiturbances due to terrestrial magnetism are eliminated and it becomes possible to standardize the instrument accurately.

Hydraulic Analogies.—In "La Lum. Elec.," March 10, Mr. Claude illustrates and describes some simple analogies. After comparing a continuous current to a current of water in a pipe from a high to a low reservoir, he illustrates self-induction by showing that when the valve is suddenly closed the inertia of the liquid will momentarily raise the pressure

to a greater one than the original, while if the valve is suddenly opened some time will be required before the current is steady (the usual hydraulic ram might also be given as an analogy); capacity he illustrates by placing in the circuit of the pipe a large reservoir, in the middle of which is an elastic diaphragm, which permits no liquid to pass, the charging of this condenser will extend the diaphragm in one direction, accumulating a certain limited amount of water in that vessel, the discharge is illustrated by opening a communication with this vessel; the action of condensers in series is shown by placing a number of these vessels with diaphragms in series, and a shunted condenser is shown by connecting the inlet and outlet by a pipe; accumulators may be illustrated by the same device but of very large proportions; to illustrate electric oscillations as produced by charging and discharging a condenser, he uses the same device but makes the connecting pipes very large, if the valve be then opened suddenly the rush of the water current will produce a greater pressure than that due to the height, which will increase the tension of the diaphragm, after which the diaphragm will act in the reverse direction, which process will be repeated, producing an oscillating current until equilibrium has been established; if the resistance in the pipe is increased the oscillations will be diminished.

Determining Resistances by Alternating Currents.—An abstract of Prof. Kohlraûsch's article from "Wied. Ann." is given in the Lond. "Elec. Eng.," March 16.

Photometry of Projectors.—In "La Lum. Elec.," March 10, Mr. Guilbert replies to the recent criticism of Mr. Fery.

DYNAMOS AND MOTORS.

Alternating and Multiphase Currents from Continuous Current Armatures.—The continuation of Mr. Friese's article, abstracted in the Digest March 17, is contained in the "Elek. Zeit.," March 8. He discusses the current and watts, and gives the following results: for a closed circuit and single alternating current the current will be equal to the continuous current and the watts will be equal to 0.707 of that of the continuous current; for a two-phase closed circuit the current relation will be 0.707; the phase difference is 45 degrees and the watts are equal; with open two-phase connection the current ratio will be 0.5 and the watts will be equal; for closed circuit three-phase connection three currents of 0.866 times the continuous current will be obtained, while the watt ratio will be 0.917; for the open connection three currents of half the continuous current will be obtained, while the watt ratio, as before, will be 0.917; with four-phase closed circuit there will be four currents, each 0.707 times the continuous current, the phase difference will be 45 degrees and the watts will be the same as with continuous currents; he then discusses the case of a multiphase connection, using several independent circuits, and shows that in certain cases the watt capacity will be reduced to 50 per cent.; for the open four-phase connection the current ratio is 0.5, while the watts are equal.

TRANSFORMERS.

Ekhart Transformer.—The principal feature of this transformer, which is illustrated in the Lond. "Elec. Eng.," March 16, is that the coils may be removed, inspected and replaced in a very short time; the external magnetic circuit, in the form of a rectangle, is unbroken, the coils are inserted in the opening and the iron in the inside of the coils consists of two pieces shaped somewhat like keystones of an arch, and are wedged in place by driven wedges, making a good magnetic joint.

Buried Transformers.—According to the Lond. "Elec.," March 16, large buried transformers are used in the Scarborough station, described in all the English journals of March 16, as a compromise between the house transformer and the sub-station system; the system is recommended editorially.

Early Transformer with Closed Magnetic Circuit.—Mr. Tanner, in the Lond. "Elec. Rev.," March 16, quotes at some length from a British patent to Thomas Allen, June 24, 1852, No. 14,190, in which four induction coils are connected at their iron cores at the ends in such a way as to form a complete iron circuit in the form of a square, the intention being to form "a complete electromagnetic circle"; illustrations from the patent are given.

ARC AND INCANDESCENT LIGHTS.

Controlling the Difference of Potential.—A French firm undertakes to replace the present lamps with others of higher efficiency, sharing the profit with the consumers; as a slight difference of potential in high efficiency lamps makes a very great difference, it is necessary to regulate the potential; an apparatus for doing this is described and illustrated in "L'Elec.," March 10. A fine wire coil connected to the mains makes a contact with one or the other of two points when the potential increases above 112 volts or falls below 108 volts; these contacts connect a motor in circuit, which drives a set of cams, which in turn open or close short circuits of some voltameters, so that if the potential is too high it will be lowered by the insertion of these voltameters; they are made preferably of copper in alkaline liquids, thus developing only comparatively small differences of potential; when not in circuit these voltameters are short circuited, so as to be ready to take a charge.

ELECTRIC RAILWAYS.

Electric Railways in Europe.—"L'Ind. Elec.," March 10, publishes what constitutes undoubtedly the best and most complete table of statistics of electric railways in Europe in operation at the beginning of this year; it gives also a brief description of those in course of construction and a list of those projected. In the table they are classified according to countries, and the most important information is given with but few omissions in 16 columns of the tables, which occupy four full pages. Germany leads with a length of 102 kilometres and 2,934 kilowatts, after which come England with 71.4 kilometres and 2,993 kilowatts, France with 41.4 and 1,796; Austria and Hungary, 33.4 and 1,115; Switzerland, 23.6 and 706. The total number of lines is 43, total length, 305 kilometres; total power at the stations in kilowatts, 10,654; the most usual potential, 500 volts; the number of motor cars and locomotives, 538; and the number of trailers, 151. The systems are divided as follows: Accumulator, 2; overhead conductor, 31; central rail, 8; underground conductor, 2. The City and South London Railway leads in power, consuming 1,200 kilowatts; next comes the Liverpool line with 900; the maximum grade of any is 10.5 per cent. on ordinary rails and 25 per cent. with rack and pinion. There are 24 lines in course of construction, which will probably run at the end of the year. Among other things the table shows that a large number of the systems used are American; on quite a number the voltage is from 2 to 300; where two motors are used they are generally of 11 kw.

A brief summary taken from an Italian book is also given in "La Lum. Elec.," March 10.

Heilmann Locomotive.—"L'Elec.," March 10, contains an article by Mr. Haubtmann, in which he makes a comparison of this locomotive with the usual steam locomotives in use in France; he expresses himself in favor of electric traction for high speeds, but does not think that this is the proper solution, as the usual steam locomotives are much in advance of this one; he believes the solution will be by means of the present system of electric railways with central power stations. In the Heilmann locomotive he finds that one indicated horse power is obtained with a weight of about 308 pounds; after making some calculations he finds that

to mount a grade of 8 per cent. at a speed of 27 miles an hour the steam engine of the Heilmann locomotive must develop 700 h. p. in order to produce a useful power of 410 h. p. at the wheels; he believes that in that portion of the run this locomotive was furnishing all the power it could; if the locomotive is alone, without the train and on a straight level road, he believes that with this power a greater speed than 54 to 60 miles an hour cannot be obtained, and that for the intended speeds of 75 to 90 miles an hour the steam engine must generate from 1,500 to 2,250 h. p., as shown in a table which he gives. He then quotes actual runs made with steam locomotives, and shows that the results are better than those which have been made with the Heilmann locomotive.

The Lond. "Elec. Rev.," March 16, calls attention to the fact that the speed of the armature is a prime factor in the efficiency of an electric motor and shows that an electric motor is at a much greater disadvantage in starting a train than a steam engine; the efficiency of a motor is very high at constant speed, but this or anything approaching it is just the condition which cannot be obtained; by way of illustration he compares the Heilmann locomotive to a pump and water turbine, the pump being driven by a steam engine; every time the turbine is started a current of water runs through without doing any work, the energy of the water not being available until speed has been obtained; but if the turbine be replaced by a water pressure engine with pistons and cylinders, the water cannot run through without doing work; this is the case with the steam engine; it considers the Heilmann locomotive an obvious absurdity.

The same issue contains a reply to Mr. Lea, which, however, contains nothing new.

High Speed Railway.—In a long editorial in the Lond. "Elec. Rev.," March 16, the Behr system is discussed unfavorably, special attention being called to the centrifugal force in rounding curves; the Lartigue, or single rail system, is to be used and the centre of gravity is to be maintained at the rail level, that is, at the point of support; the editorial calls attention to the fact that this would not take up the effect of the centrifugal force on the passengers, and it is claimed that it is absolutely essential for passenger traffic that the resultant of gravity and centrifugal force be a normal to the surface of the seats; it does not consider the scheme practicable.

Series Traction.—In the Lond. "Elec. Eng.," March 16, Mr. N. W. Perry compares series traction with the usual method and describes briefly his series system, which has already been described in these columns.

CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

Balancing a Three-Wire System with Only One Machine.—Mr. Edgcumbe, in the Lond. "Elec. Rev.," March 16, suggests a system in which a shunt dynamo is connected directly to the outside mains, and through multiple switches to any desired cells at the ends of a series of accumulators, the neutral wire being connected through a multiple switch to any of the accumulators near the middle of the series, thus enabling an excess of volts to be obtained on either side.

Rates of Charging.—The Lond. "Elec.," March 16, discusses unfavorably the custom of allowing an increasing rate of rebate to large consumers, as such consumers are more often a nuisance; those which should be encouraged are not necessarily those whose bills are large, but those whose bills are large in proportion to the lamps they use, however small the actual bill may be.

Synchronizing Alternators.—Mr. Ruddle, in the Lond. "Elec. Rev.," March 16, states that during the past 15 months they have synchronized at their station about 1,000 times without the slightest trouble and without having found it necessary to use any special fuses or switches, the only apparatus being a synchronizing lamp; he thinks that the synchronizing depends very much on the governor of the engine; with a slow speed Corliss engine coupled by ropes, alternators may be synchronized without any fear, no matter what the conditions of the load.

Synchronizing Indicator.—According to "La Lum. Elec.," March 10, the Lahmeyer synchronizer consists simply of a vibrator operated by an electromagnet and producing a sound, the disappearance of which indicates that synchronism is attained.

Polyphase Currents.—An Academy paper by Mr. Blondel on a new simplified method for the calculation of polyphase alternating currents is abstracted at some length in "L'Ind. Elec.," March 10.

Electric Windlasses.—In "La Lum. Elec.," March 10, Mr. Boucherot gives an illustrated description of the installation of windlasses in a large warehouse in Paris.

Automatic Cut-Out.—The Lond. "Elec. Eng.," March 16, gives an illustrated description of a large automatic cut-out for 1,500 amperes, in which a short solenoid releases a spring switch.

WIRES, WIRING AND CONDUITS.

Ship Wiring.—The article by Mr. Kennedy is continued in the Lond. "Elec. Rev.," March 9; he advocates having the switch and fuse in one cover, against which practice he claims there is some unaccountable prejudice; fuses should be prepared on a carrier, the practice of using a wire held beneath screws should not be allowed; he claims that perfect conductivity is much more important than perfect insulation, even though it is neglected by the rules; regarding insulation he claims that with lead covered wires rubber may be dispensed with if every joint is watertight; as joints are the greatest difficulties to deal with, the fewer they are the better, which he gives as one of the greatest advantages of single wiring over double wiring; the single-wire system which he advocates is really a two-wire system, with a concentric wire thoroughly insulated and concentric with the return wire, which may be insulated or not.

A large amount of correspondence on this subject is contained in the same issue; Mr. Tidd states that with double wiring the leads may be run as desired regardless of their position with reference to the compass, on which they will have no appreciable effect; he takes exception to Mr. Kennedy's statements regarding the fittings and believes the best preventive of poor wiring is not to insist on a complicated system; the single-wire system, he says, is by far the cheapest, but by far the most dangerous, owing partly to the number of poor contacts made with the ship; the concentric wire system is very good until a fault occurs, but that the trouble then begins; this safeguard is quite unnecessary on board ship; the ideal system is one which anybody can repair. Mr. Cline thinks that both the single and double wire system are good if properly carried out; in the former the positive terminal should be connected to the ship, which will avoid corrosion at the screw contacts; the lead for each lamp should be brought from one side and the return from the other side of the ship; all lamps on the compass deck or the one below it should be wired on the double-wire system up to a distance of 30 feet; there should always be two lamps at each compass, one on each side with concentric or twin wires brought through brass or copper pipes from below up, and the number of lamps in these quarters should be equalized, one-half being run on each side of the ship. Mr. Boot speaks of using two deviation cards to steer by, one for the day, when the dynamo is not running, and the other for the night; if the field of the dynamo causes the error, its position or that of the mains should be altered, but if this is impossible, the error produced, which is a constant factor, should be taken into ac-

count. Mr. Mavor claims that single wiring is the worst and being the cheapest is the one generally adopted by incompetent firms; double wiring is much preferable, and its great safety and reliability are well purchased at the increased cost; no system is permanently durable, unless persistently and continuously protected throughout by a waterproof sheathing; wood casing, no matter how good, cannot be made fireproof, a statement which he emphasizes, but concentric wiring can be made absolutely fireproof and waterproof; with ordinary precautions a compass disturbance can be kept well within one degree with single wiring; double wiring gives only a fancied security; concentric wiring in the neighborhood of the compass entirely avoids disturbances.

In the third article of the series by Mr. Kennedy in the Lond. "Elec. Rev.," March 16, he discusses double wiring; he claims that in this system there is double the chance of faults occurring than in single wiring; but little information is given in this section.

The same number contains some correspondence, giving, however, nothing new; Mr. Barker claims that lead covered cables are undeniably the best, the greatest difficulty being in the frequency with which the joints of the lead covering fail, even when made by the most skillful workmen; the double wire system he believes to be not only the safest, but the surest to keep in good working order.

Loss of Volts in Alternating Leads.—A Physical Society paper by Mr. Parry is reprinted in the Lond. "Elec. Eng.," March 9, in which he discusses the extra loss due to inductance, which he says can be taken into account with very little extra trouble and by approximations, he claims it is remarkably simple; he first discusses the subject mathematically on a basis of the vector properties of the quantities involved (giving results which, however, are not sufficiently simple for ordinary practical use); he then gives a series of curves, showing the principle according to which graphical tables may be made, but the curves which he gives are not sufficiently complete, illustrating only the method (their alleged simplicity is hardly sufficient to warrant their general use); in conclusion he gives an empirical expression for an approximate determination, which, though simpler, is nevertheless somewhat complicated.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Indicating the Positions of Ships in a Harbor.—According to the Lond. "Elec. Eng.," March 9, Mr. Stephenson has been making some successful experiments for locating the positions of vessels at harbor entrances when the weather prevents observations from being made; he proposes to lay a cable on the bottom, charging it with some sort of intermittent current; the vessels have a coil of bare copper wire dipping into the water at the bow and another at the stern, and connected through a telephone; experiments showed the method to be feasible and the instrument to be very delicate; in another system there are no earth connections, the wires being insulated and the action being a true induction through the water.

Telephone Rates in Europe.—The Lond. "Elec.," March 16, gives the rates for most of the European countries, all of which, with the exception of those in London, are very low as compared with those in this country.

ELECTRO-CHEMISTRY.

Minimum Electromotive Force in Electrolysis.—In an Academy paper abstracted in "L'Ind. Elec.," March 10, Mr. Leblanc claims to have anticipated Mr. Nourrison by about three years in verifying experimentally that there is a minimum and constant electromotive force in the electrolysis of different substances; the figures for a number of alkaline compounds are given; for different bases and acids he finds that it is the same in all, being about 1.70 volts, which he explains by assuming that they are all dependent on the same phenomena, namely, the decomposition of water, which he therefore believes is not a secondary but a primary reaction. In a subsequent note by Mr. Berthelot he claims to have published this twelve years ago, citing the reference to his publication.

Purification of Sewage.—The Lond. "Elec. Rev.," March 9, discusses the Hermite process; it estimates roughly that the power required will be about 1 h. p. working continuously for every 500 head of the population; it discusses the question whether the antiseptic chemicals are cheaper when prepared in this way than when chemicals are simply added to the water; it thinks that this depends on the position of the town; where a supply of water is plentiful, it may be much cheaper to add the chemicals. The Lond. "Elec.," March 9, quotes at some length from the medical paper, "Lancet," regarding the Hermite process at Worthing, giving, however, nothing new.

Theryc-Oblasser Accumulator.—Mr. Theryc, in the Lond "Elec. Rev.," March 16, gives some figures regarding this accumulator, without, however, giving a clear description of it. It is claimed that 13 amperes (ampere hours) per pound have even been exceeded at a discharge of .45 ampere (per pound); the accumulators have been tested by a French railway and the French Navy for fifteen months; a locomotive is being built for 700 nominal and 1,100 maximum horse power for running at a speed of 65 miles per hour on a level. A horse power can be obtained with 48 pounds of total weight in a volume of one-third of a cubic foot, which is claimed to be from 2 1-2 to 6 times less than with the best accumulators known; the lowering of the capacity is less than 10 per cent. for each increase of .45 ampere per pound, and they can stand without damage up to about 2.5, 4 and even 6 amperes per pound, the nominal rate being from 1.36 to 1.80, which is claimed to be from four to six times more rapid than that of the best known accumulators for the same output.

Coloring Leather.—A process is described in the "Zeit. fuer Elek.," March 1, in which the leather is placed on a horizontal conducting table, preferably zinc, forming the positive pole of the electrode; as much of the coloring liquid as will be retained is poured over this and the negative pole connected to the leather; decomposition takes place and the coloring matter penetrates the leather; the current is continued for a few minutes. Designs can be produced by covering the leather with a metallic plate in which the pattern has been cut, this template being connected to the negative pole; below the open spaces the coloring will be darker than below the metal; the process can be used for all animal and vegetable substances.

Electrolytic Bleaching.—According to "La Lum. Elec.," March 10, the Knoeffler & Gebauer process consists in passing a current at the rate of 600 amperes per square metre of electrodes through a 5 to 10 per cent. solution of chloride of sodium, in which free chlorine will be generated in increasing proportion to the temperature; if, for instance, the increase is 21 degrees there will be 0.40 per cent. of free chlorine, and if the bath is maintained at this temperature by regulating the liquid which is added, the regularity will be perfect and will require no diaphragms and no addition of chalk.

MISCELLANEOUS.

Welding.—The "Elek. Echo," March 3, contains some comparative data for the power used in the Thomson process and in the Lagrange & Hoho process (in which the iron is heated by immersion in an electrolyte when the current is very strong); it assumes that the strength of the welds in the latter are, or can be, the same as in the blacksmith's process; regarding the consumption of energy it shows that the mean per centimetre of cross-section is almost three to four times as great in the latter process as in that of Thomson.

Electric Canal Towing.

We illustrate a system of electrical towing for canals, the invention of Mr. T. D. Davis, 628 Park avenue, Syracuse, N. Y., a gentleman well known in connection with steam propulsion on the Erie Canal.

The system provides for towing canal boats in tows or trains by an electric motor running on a narrow gauge track on the bank of the canal. Each end of the boat is connected to the inner rail by a triangular guide, the outer end of which is directed with a horizontal guidewheel on each side of the rail and also a vertical wheel carrying the weight of the free end. These guides hold the boat at a uniform distance from the bank and the boat therefore requires no steering.

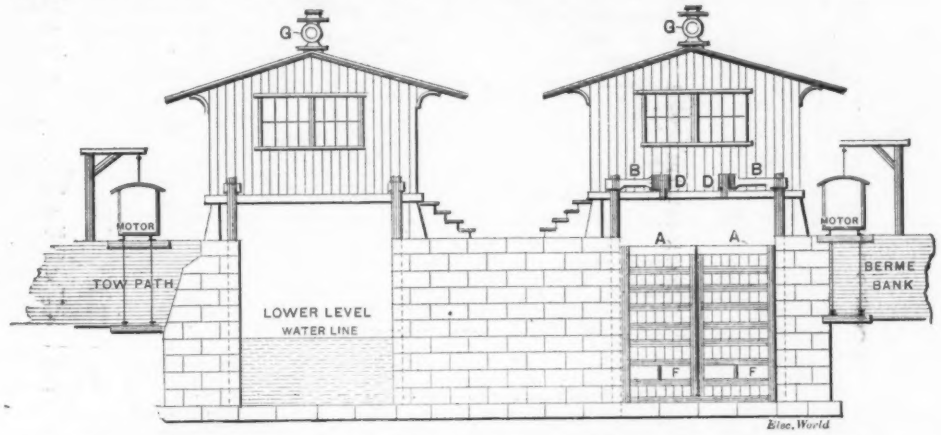


FIG. 1.—VERTICAL SECTION OF LOWER END OF DOUBLE LOCK.

By this system many more boats can be moved through the locks, and as the amount of traffic depends upon the locking, the capacity of a canal will thus be largely increased.

The time now required to lock a loaded boat down is about 10 minutes; adding three minutes for changing the lock for the next boat makes a total of 13 minutes, and at this rate about 112 boats can be locked in 24 hours. With a lock provided with electrical equipment and the boats delivered at the locks in perfect line with the lock, as this system provides, the time can be reduced to about 7 1-4 minutes, at which rate 200 loaded boats can be locked through each way every 24 hours.

Fig. 1 is a vertical section of the lower end of a double lock on the Erie and Oswego canals, and Fig. 2 a plan of one chamber of a lock. *A A* are the gates; levers *B B* are secured to the upper ends of the vertical shafts to which the gates are attached, and integral with the levers are sectors operated by pinions *D D*, or by frictional gearing driven by a small electric motor. The valves *F F*, for filling and emptying the lock, can also be operated by the same motor. The whole will be under the control of and operated by one man, without leaving his position. Fig. 3 is a plan view of a lock, showing a boat leaving the lock on the towpath side and one entering it on the berme bank side.

In order to enter a lock it is necessary for the boat to be in perfect line with the chamber, as shown by the boat, *K*. To place a boat in this position, when steered by rudders, as now practiced, required from three to five minutes' time, while about two minutes only is required to pull the boat into the lock when once in line. Thus the time lost in entering or starting the boat into the lock is by the towing system all saved.

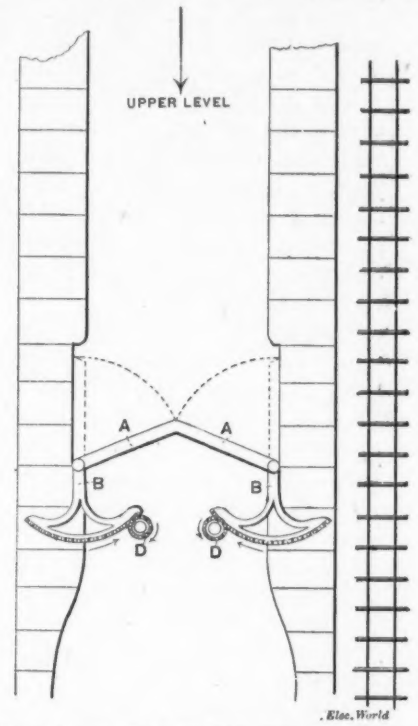


FIG. 2.—PLAN OF CHAMBER OF A LOCK.

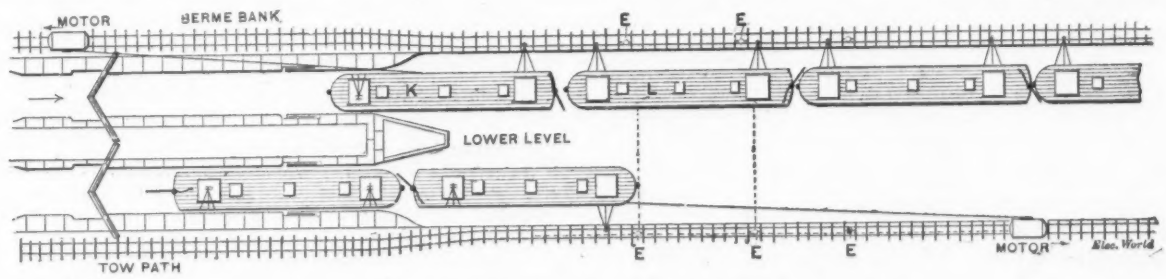


FIG 3.—BOATS ENTERING AND LEAVING LOCKS.

Annual Report of the Bell Telephone Company.

The annual meeting of the Bell Telephone Company was held in Boston Wednesday, March 28, and the following directors were re-elected: T. B. Bailey, Francis Blake, C. P. Bowditch, G. L. Bradley, Alex. Cochrane, W. H. Forbes, H. S. Howe, C. E. Hubbard, G. G. Hubbard, J. E. Hudson, C. E. Perkins and Thomas Sanders.

The report of the year shows that the company earned in 1893, $5,781,076 gross and $3,925,485 net. Of the net all was paid in dividends except $586,329, which was charged off to depreciation.

The annual report states that the output of telephones amounted during the first seven months of the year to more than 25,000, when the financial panic caused the return of instruments to exceed the output, and part of the gain thus made was lost, the total output of the year being 13,771. The number of daily exchange connections fell off during the latter part of the year, so that the aggregate which had previously shown a marked increase from year to year has remained almost unchanged since the last report. In spite of the financial stringency, however, most of the licensed

companies have found means to complete the work of extension and improvement already in hand. Noteworthy progress has been made in the laying of the underground system and at the close of the year more than a third of the total mileage of exchange wire of the whole country was in operation in underground conduits.

The use of the metallic circuit has been greatly on the increase, the number of subscribers having stations equipped with that class of service being 37,648 at the close of the year, as against 23,053 at the beginning. There has been added to the long distance system during the year 423 miles of line, 9,934 miles of wire and eight new offices, making in operation Jan. 1, 1894, a total of 3,695 miles of poles and 63,529 miles of wire.

The larger cities to which the lines were extended, and in which service was opened during the year, are Detroit, Cleveland, Cincinnati, Dayton and Indianapolis. The line from Dayton to Indianapolis forms a link in a proposed through line connecting Pittsburgh and places to the east with St. Louis and the principal cities en route. The line connecting Detroit, by the way of Toledo and Maumee, with Cincinnati, crosses the above line near Dayton, and reaches directly, and through such connection, a large amount of extra territorial work of the Central Union Company in the States of Ohio and Indiana. The long distance lines now reach and connect the exchanges of 26 companies licensees.

The proportion which telephone work has assumed is shown by the fact that the telephone companies operating under licenses from the Bell company have during the past nine years expended about $42,000,000 upon extensions and betterments of their plants. This sum is divided in round numbers as follows: Overhead and exchange, $12,000,000; subways and cables, $14,500,000; buildings, $6,000,000; pole line, $9,000,000. Previous to that period the construction account stood at the sum of $31,000,000, which makes a grand total of $73,000,000. The following statistics affording a comparison between the use of the telephone in this and other countries may prove of interest:

In the United States, with a population of 63,000,000, there are 237,000 exchange subscribers, a number larger than that of all continental Europe, with its population of more than 300,000,000. In Great Britain, with a population of 38,000,000, there are but 45,000 telephone subscribers; in Germany, with 49,000,000, 86,500 subscribers; in France, with 38,000,000, no more than 24,000 subscribers.

The general system of the operating companies throughout the country has been to charge the subscriber a fixed sum for exchange service, a plan which appears to have worked satisfactorily, but it is by no means certain that in the future a system of tariff rates, that is, charging a subscriber according to the number of times a telephone is used, may not prove more equitable. Some experiments have been made to see if in the great cities the case of those who want only a limited use of the telephone at a lower rate cannot be met. Application has been made to the Legislature at its present session for authority to increase the capital stock of the company to $50,000,000. That amount is necessary, it is claimed, for the perfection of the lines already built and for the development and extension of the system to paying points in the United States.

The following is the statement of the treasurer of the American Bell Telephone Company for the year ending Dec. 31, 1893:

LEDGER BALANCES DEC. 31, 1893.

DEBTORS.

Telephones	$1,266,182.03
Real estate	950,984.11
Stocks	37,065,131.12
Merchandise and machinery	13,311.83
Bills and accounts receivable	3,573,053.07
Cash and deposits	2,843,678.36

CREDITORS.

Capital stock		$20,000,000.00
Debenture bonds, 1888		2,000,000.00
Bills and accounts payable*		1,550,596.07
Patent account (profit and loss)		10,137,493.08
Profit and loss		5,682,227.13
Reserve		4,191,012.63
Surplus		2,151,011.61
	$45,712,340.52	$45,712,340.52

COMPARATIVE STATEMENT OF EARNINGS AND EXPENSES.

EARNINGS.

	1892.	1893.
Rental of telephones	$3,303,753.10	$3,513,711.42
Dividends	1,422,047.93	1,824,431.98
Commission from ex.-terr. lines	101,306.32	108,621.38
Commission from teleg. business	29,417.31	29,192.79
Real estate	67,868.14	68,097.06
Interest	168,830.22	225,936.28
Miscellaneous	7,663.57	11,086.08
	$5,100,886.59	$5,781,076.99

EXPENSES.

Expenses of operation	$378,272.89	$392,770.39
Legal expenses	87,767.28	114,852.47
Real estate	35,666.19	44,532.41
Interest on taxes	279,638.93	300,368.38
Commission	648,689.25	690,380.58
Royalty	10,000.00	10,000.00
Concessions	246,914.53	257,829.92
Miscellaneous	2,262.74	44,857.15
	$1,689,211.81	$1,855,591.30
Net earnings	3,411,674.78	3,925,485.69
Surplus account, Dec. 31, 1892	2,151,011.61	
Net earnings, 1893	3,925,485.69	
		6,076,497.30
Regular dividends, 1893	$2,214,156.00	
Extra dividends, 1893	1,125,000.00	
Reserve for general depreciation	450,000.00	
Reserve for depreciation of insts	136,329.69	
		3,925,485.69
Surplus account, Dec. 31, 1893		$2,151,011.61

Census Statistics.

Hon. Carroll D. Wright, Commissioner of Labor, in charge of the completion of the eleventh census, has transmitted to the Secretary of the Interior a report which presents preliminary totals for all classes of mechanical and manufacturing industries in the United States as prepared by the Division of Manufactures. The following are the statistics relating to the electrical industry:

ELECTRICAL APPARATUS AND SUPPLIES.

Number of establishments reporting	189
Aggregate capital represented	$18,997,337
Total value of plants	6,170,507
Value of land	714,542
Value of buildings	1,496,293
Value of machinery, tools and implements	3,959,672
Live assets	12,826,830
Miscellaneous expenses	1,154,462
Average number of employes	9,485
Total wages	$5,366,188
Officers, firm members and clerks above 16 years, males	640
Wages for same	$826,986
Officers, firm members and clerks above 15 years, females	43
Wages for same	$22,152
Operatives, skilled and unskilled, above 16 years, males	6,221
Wages for same	$3,469,140
Operatives, skilled and unskilled, above 15 years, females	970
Wages for same	$243,039
Children operatives	44
Wages for same	$7,543
Pieceworkers, males, above 16 years	1,068
Wages for same	$613,707
Pieceworkers, females, above 15 years	499
Wages for same	$183,621
Children pieceworkers, not any.	
Cost of materials used	8,819,498
Value of products, including receipts from custom work and repairing	19,114,714

ELECTRIC LIGHT AND POWER.

The statistics under this classification are confined to the

*Of this amount $1,200,000 is for the dividends payable Jan. 15, 1894, to stockholders of record, Dec. 30, 1893.

city of New York, the District of Columbia and the city of St. Louis. Commissioner Wright stated that it was found impracticable to make a complete canvass of the entire United States for the collection of statistics pertaining to the generation of electricity for lighting and power purposes.

Number of establishments reporting	144
Aggregate capital represented	$33,838,549
Total value of plant	19,167,012
Value of land	1,743,017
Value of buildings	2,106,418
Machinery, tools and implements, value of	15,317,577
Live assets	14,671,537
Miscellaneous expenses	755,201
Average number of employes	2,004
Total wages	$1,556,623
Officers, firm members and clerks, males, above 16 years	205
Wages for same	$268,325
Officers, firm members and clerks, females, above 15 years	5
Wages for same	$3,056
Operatives, skilled and unskilled, males, above 16 years	1,791
Wages for same	$1,284,502
Operatives, skilled and unskilled, females, above 15 years	1
Wages for same	$240
Children operatives	2
Wages for same	$500
Pieceworkers, males, above 16 years, not any.	
Pieceworkers, females, above 15 years, not any.	
Children pieceworkers, not any.	
Cost of materials used	1,155,789
Value of products, including receipts from custom work and repairing	4,783,224

ELECTROPLATING.

Number of establishments reporting	313
Aggregate capital represented	$33,838,549
Total value of plant	888,173
Value of land	155,760
Value of buildings	129,420
Machinery, tools and implements, value of	602,993
Live assets	1,162,961
Miscellaneous expenses	182,826
Average number of employes	2,162
Total wages	$1,260,475
Officers, firm members and clerks, males, above 16 years	388
Wages for same	$364,115
Officers, firm members and clerks, females, above 15 years	9
Wages for same	$4,608
Operatives, skilled and unskilled, males, above 16 years	1,529
Wages for same	$802,578
Operatives, skilled and unskilled, females, above 15 years	87
Wages for same	$28,152
Children operatives	68
Wages for same	$13,794
Pieceworkers, males, above 16 years	73
Wages for same	$43,750
Pieceworkers, females, above 15 years	8
Wages for same	$3,478
Children pieceworkers, not any.	
Cost of materials used	1,084,057
Value of products, including receipts from custom work and repairing	3,121,642

GALVANIZING.

Number of establishments reporting	27
Aggregate capital represented	$1,301,973
Total value of plant	464,593
Value of land	144,300
Value of buildings	128,900
Value of machinery, tools and implements	191,393
Live assets	837,380
Miscellaneous expenses	99,192
Average number of employes	846
Total wages	$473,111
Officers, firm members and clerks, males, above 16 years	83
Wages for same	$110,233
Officers, firm members and clerks, females, above 15 years	2
Wages for same	$1,000
Operatives, skilled and unskilled, males, above 16 years	733
Wages for same	$349,228
Operatives, skilled and unskilled, females, above 15 years	4
Wages for same	$880
Children operatives	11
Wages for same	$3,650
Pieceworkers, males, above 16 years	13
Wages for same	$8,120
Female pieceworkers, above 15 years, not any.	
Children pieceworkers, not any.	
Cost of materials used	1,940,712
Value of products, including receipts from custom work and repairing	2,957,143

Apparatus for the Taking of Alternate Current Curves.

BY N. H. GENUNG.

Joubert is supposed to have made the first real reproduction of alternate current curves by employing a contact point rigidly attached to and revolving with the armature of the generator, and adjusted so as to make connection with a fixed brush once in each revolution. By this means he charged a condenser to the voltage of the generator at some definite and known part of the period. Some time after this curves of E. M. F. and current in both the primary and secondary of induction coils were taken by Dr. Duncan and others, the above mentioned contact device being employed. In order that the exact workings of a transformer may be known, the instantaneous values of current and E. M. F. in both circuits must be simultaneously picked out and measured at definitely known positions throughout a complete cycle, and the results plotted. Prof. Ryan was the first to undertake the practical carrying out of a piece of work of this kind, and the numerous papers published by him and his associates in the year 1890 containing an enormous amount of valuable experimental data, have given us exact knowledge as to the relative phases of current and E. M. F. on commercial apparatus working under varying conditions, which, up to that time, had been a matter of pure guess work. Thus, both theoretically and practically, the transformer, as to its working conditions, was placed on a perfectly definite basis. In other words, "transformer indicator diagrams" have done for the transformer what characteristic curves have done for the continuous current machine, and what the indicator card has done for the steam engine. Prof. Ryan in his work employed necessarily the contact maker and an electrometer of his own design. Many others have since employed essentially the same outfit in continuing these valuable investigations. Aside from this alternate current working has of late become so prominent a feature of electrical engineering that in many of our leading technical schools the taking of transformer curves by the instantaneous contact method has come to form a part of the prescribed laboratory course.

The arrangement of contact maker and electrometer, as employed by Prof. Ryan and others, is esssentially as shown in Fig. 1. The lines *M* and *N* come from a switch so arranged

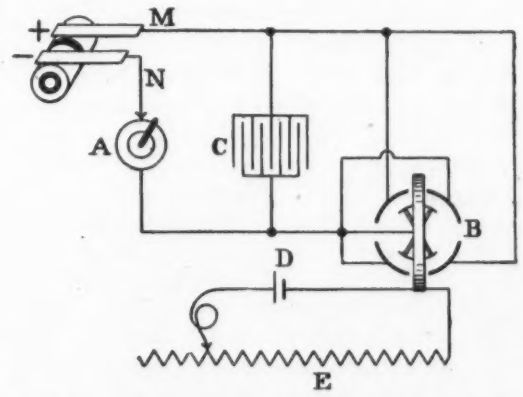


FIG. 1.—ARRANGEMENT OF APPARATUS.

that pressures from different circuits may be conveyed to the electrometer through the contact device *A*. Values of current are obtained by measuring the fall of potential around a non-inductive resistance of known value through which the current is made to flow. The condenser shown at C has usually been found necessary to obviate the effect due to leakage of the electrometer, the latter being of extremely small capacity and the circuit being closed through the contact points for but a very small fraction of each revolution. The electrometer, as designed and improved by Prof. Ryan for the purpose in view, is shown in Fig. 2.

This instrument, not so perfected, was employed by Prof. Ryan in his earliest work on transformers, and has ever since been employed by him and many others almost exclusively in work of the same or of a similar nature. The

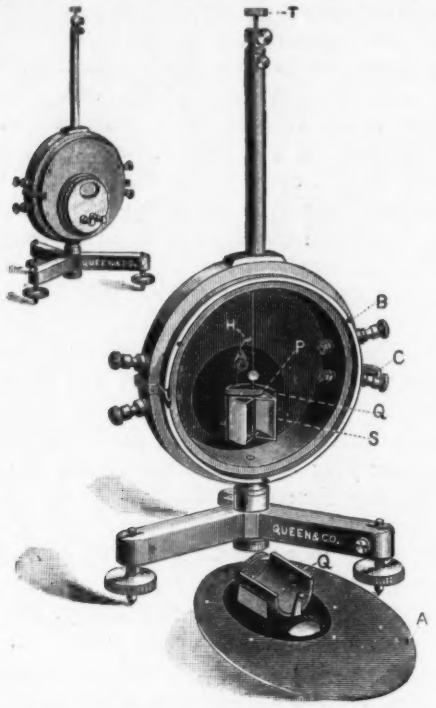


FIG. 2.—RYAN ELECTROMETER.

quadrants are here mounted on quartz plates to insure high insulation, thus rendering the use of a condenser seldom, if ever, necessary, and are faced with mica so as to prevent short circuiting should the needle accidentally touch them. The cover plates carrying the quadrants are held accurately in position by spring clips and pins, and the opposite quadrants are connected automatically by metal strips. A small magnetic needle is rigidly attached to the system and situated exactly at the centre of the circular case, on the outside of which are wound two coils of a different number of

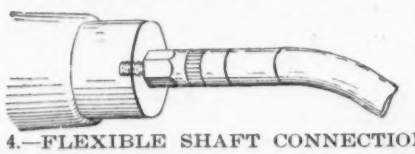


FIG. 4.—FLEXIBLE SHAFT CONNECTION.

turns, which, together with the binding posts for the same, are completely insulated by means of hard rubber. The instrument may be used in one of two ways, either the E. M. F. may be calculated from the deflections produced, or a zero method may be employed, the needle being returned to zero by means of a current in one or both of the coils acting on the magnetic needle at the centre. The latter method is the more accurate and is entirely free from errors due to variations in the earth's field. The voltages are with this latter method determined in terms of the current flowing in the coils surrounding the case. The strength of current flowing may be regulated and its value determined very conveniently and accurately by the combination of a standard cell and known resistances, as shown in Fig. 1 and as employed by Prof. Ryan.

The contact maker which is to accompany this or whatever other measuring device it may be desired to employ, is shown in its most complete form in Fig. 3. The metal base carries a revolving ebonite cylinder driven by means of a flexible shaft, very rigid so far as torsion is concerned, easily attached to the end of the armature shaft, as shown in Fig. 4, thus making perfect alignment of the contact maker unnecessary. Brushes connect the insulated binding posts to two brass rings on the circumference of the hard rubber cylinder. The steel knife edge plug *G* attached to ring *A* may be adjusted so as to just touch at each revolution the sharpened end of a piece of piano wire forming a part of the third brush *C*, which presses continuously against ring *B*. This brush, as shown, may be accurately set and clamped in any desired position with reference to the armature shaft by means of the finely divided scale at the end. This arrangement of brushes and rings avoids the use of flexible con-

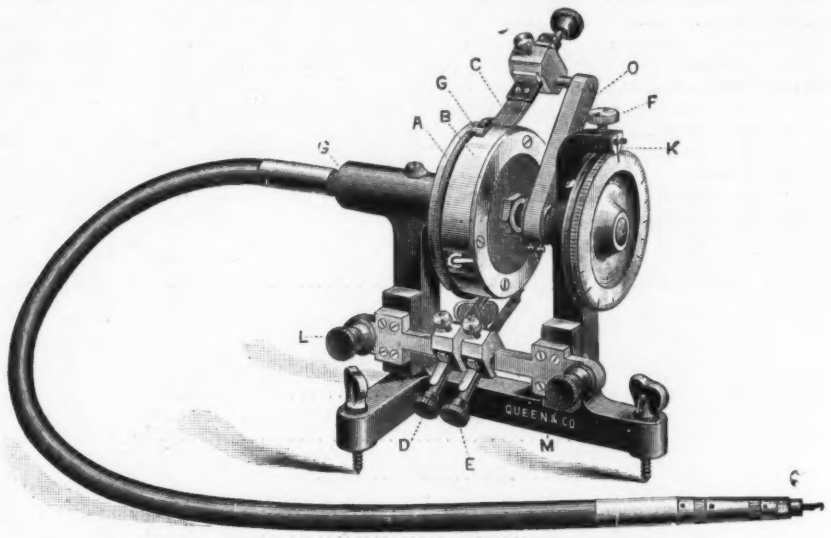


FIG. 3.—QUEEN CONTACT MAKER.

nectors, which are more or less apt to become entangled in the rotating parts. All parts necessarily handled in the course of the work are perfectly insulated, so that the operator may run no risk of coming in contact with the live circuit.

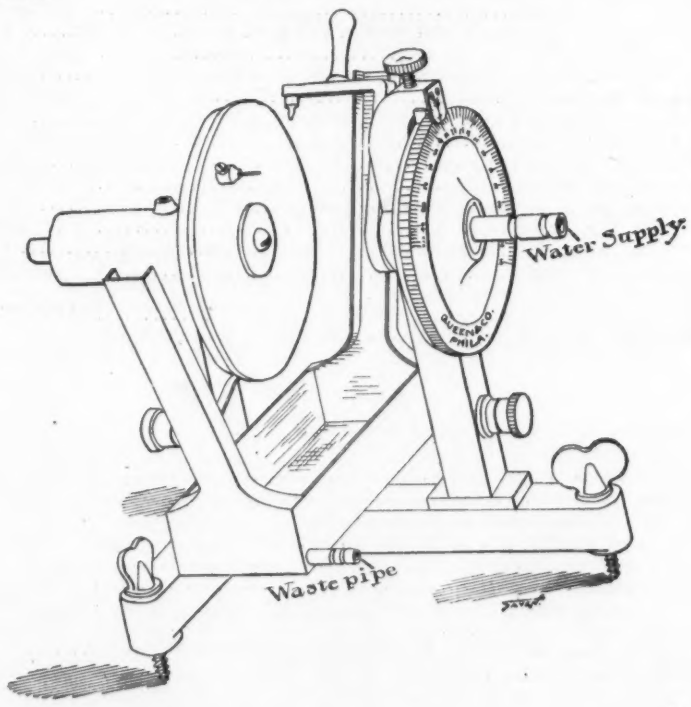


FIG. 5.—WATER JET CONTACT MAKER.

A contact maker of a somewhat different design was recently worked out jointly by Profs. Ryan and Bedell, and was fully described some time since at a meeting of the American Institute of Electrical Engineers. It differs from the other form in that a needle point is substituted for the steel plug, as shown in Fig. 5, and a fine jet of water for the third brush, the jet being maintained by a small reservoir of water a few feet above the nozzle, connection being

made by a flexible rubber tube. A binding post in metallic communication with the nozzle serves as one terminal, while connection with the needle point is made through a brush resting against the revolving disc. The nozzle points slightly away from the disc, so that there is no possibility of a second contact when the projecting needle point is in the course of its revolution, on the opposite side of the disc. Should the generator be a many pole machine, more than one contact point may be inserted, so that a contact may be had with each cycle if desired.

Both these forms of contact maker have been run for hours without interruption, during all of which time a fine sharp contact was to be had.

New Electrical Machinery.

The Walker Manufacturing Company, which has, for many years, enjoyed the reputation of being without an equal in the construction of cable railway equipments, power transmission plants, and all classes of very large machinery, has

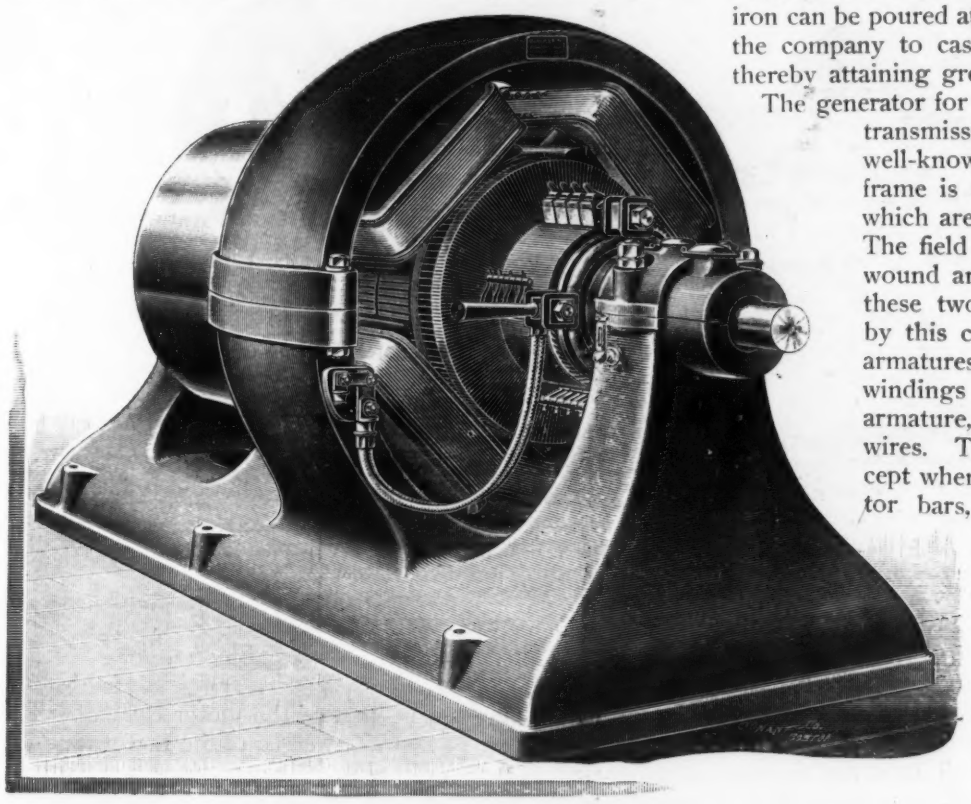


FIG 1.—THE GENERATOR.

now added to its extensive business an electrical department, and now enters the market, ready to supply electric generators for both direct and alternating currents, of any capacity, from 150 to 5,000 horse power, with an electromotive force varying from 500 to 10,000 volts, and a complete line of electric motors for both direct and alternating current work.

These machines—both generators and motors—are constructed for street railway use, ordinary power transmission, mining and a special line in which they anticipate large developments in the near future, extra large alternating machines for long-distance transmission of power. Street railway companies throughout the world, who are so well acquainted with the excellent work uniformly executed by this firm, will need but the assurance that especial attention has been given to the particular requirements of street railway engineering to insure them that the highest degree of excellence, in both mechanical and electrical construction, will be attained.

The plant of the Walker Manufacturing Company is one of the largest and most complete in the country, and is modern in all its equipment. The buildings cover 250,000 square feet of ground, are constructed of brick, iron and glass, and are situated on the shores of Lake Erie, at Cleveland, Ohio. The machine shop consists of three long bays, each containing a 30-ton travelling crane, which moves through its entire length. Iron galleries at either end are fitted up as winding rooms and for the manufacture of insulating materials.

The testing room is equipped with switchboards and resistances for testing generators, brakes for testing motors, and a 1,000 h. p. engine will be erected immediately for testing the large multipolar direct coupled generators. The tracks of the Lake Shore and Michigan Southern Railroad enter the testing room below the floor level, and all machines can be lifted by the large cranes from the testing racks directly to the cars. The pattern shops occupy a large two-story building, completely fitted up with modern wood-working machinery. Two large foundries occupy another building, and are perfect in their equipment. They contain four mammoth cupolas, spacious core ovens and numerous travelling cranes, from five to thirty tons capacity each. Fifty tons of iron can be poured at once into a single mold, which enables the company to cast their large machines in fewer parts, thereby attaining greater rigidity.

The generator for street railway and direct current power transmission shown in Fig. 1 is 250 h. p., of the well-known four-pole type, slow speed. The frame is cast in one piece with three bearings, which are of the ball and socket self-oiling type. The field magnets are of wrought iron and are wound and insulated entirely with mica. With these two path windings—the only kind used by this company—there can be no unbalanced armatures, no sparking and no heating. The windings are entirely below the surface of the armature, which is ironclad, with no binding wires. There are no joints in the windings, except where the wires connect with the commutator bars, and the insulation throughout the entire machine is sufficient to withstand at least ten times its normal requirements. The armature and commutator are thoroughly ventilated, as a current of cool air passes all through the interior of the machine. The commutator is excessively large and runs cold in regular operation. The small machines of this type are belted machines, and the larger ones are usually built on the engine shaft.

Experience has taught street railway men that the greatest cost in operating roads by electric motors has been the repairs made necessary by the rapid deterioration of the track and rail-joints. The only way to correct this evil is to entirely disconnect the motor itself from iron to iron contact with the axle, and prevent not only the hammer blow due to the weight of the motor, but the inertia blow due to the unyielding mass of the motor. Attempts have been made to accomplish this by suspending the motor at or near the centre of gravity. This eliminates the weight, but not the inertia blow, which is the most serious. This has forced those interested to the conclusion that the perfect motor must weigh as little as possible, be extremely strong in mechanical construction, should work to 25 h. p. without heating and not be in any way attached to the axle and wheels, except through springs which will do away with the hammering of the track to the greatest possible extent. This method of suspension gives the freedom of movement necessary for the removal of strain in rounding curves. The motor being built by the Walker Manufacturing Company combines these

suggestions of practical experience. It is a four-pole steel motor, weighing 1,200 pounds, has an easy capacity of 25 h. p., will run at any speed up to 25 miles an hour, is controlled by a series-parallel controller, of superior type and great simplicity, and is not attached to the axle in any way, except through yielding supports.

The illustration, Fig. 2, shows the general form of the motor, mounted upon 30-inch wheels and ordinary truck, portions of the truck being cut away to enable the motor to be more readily seen. The motor is entirely water and dust tight, the only opening being the lid over the commutator, which enables the two brushes to be easily reached. The frame is in two parts and made of steel. The gear housing and commutator lid are of malleable iron. Both gears and pinions are of steel. The shaft is large, being three and one-half inches in diameter, and two and one-half inches in the bearings. The bearings are very long and arranged for thorough lubrication with grease. The efficiency of the motor is 90 per cent. For the better understanding of the flexible support and other points, detail cuts are shown. The motor, with gears and housing, weighs 1,600 pounds.

A, trunnioned by its bearings, but not touching the axle. The motor is then supported at the rear by spiral springs, *C*, between lugs on the frame and the arms of the U, and the front end is supported by a swinging arm from the ordinary spring truck bar, *D*. It can be seen that with this suspension the motor rides freely on springs, readily adjusting itself to varying conditions, without bringing a strain or shock on any part. The gear centres are always maintained because of the U-shaped frame. Fig. 4 shows how the lower half of the frame is made to swing down, while the armature remains in place, one man being able to let it down and replace after inspecting and cleaning. The armature may be removed, if desired, from below; or, if the motor should not be over a pit, the upper half may be swung up and the armature removed from above. By referring to the figures it will be seen that all the bearing caps come off from below, and all the bolts pass down from above; and, should a nut come off, no part of the motor can fall. The bolts are not made to take the weight of the motor, and the nuts are all locked with pins. The bearings are entirely outside of the motor casing or frame, as shown by Fig. 5.

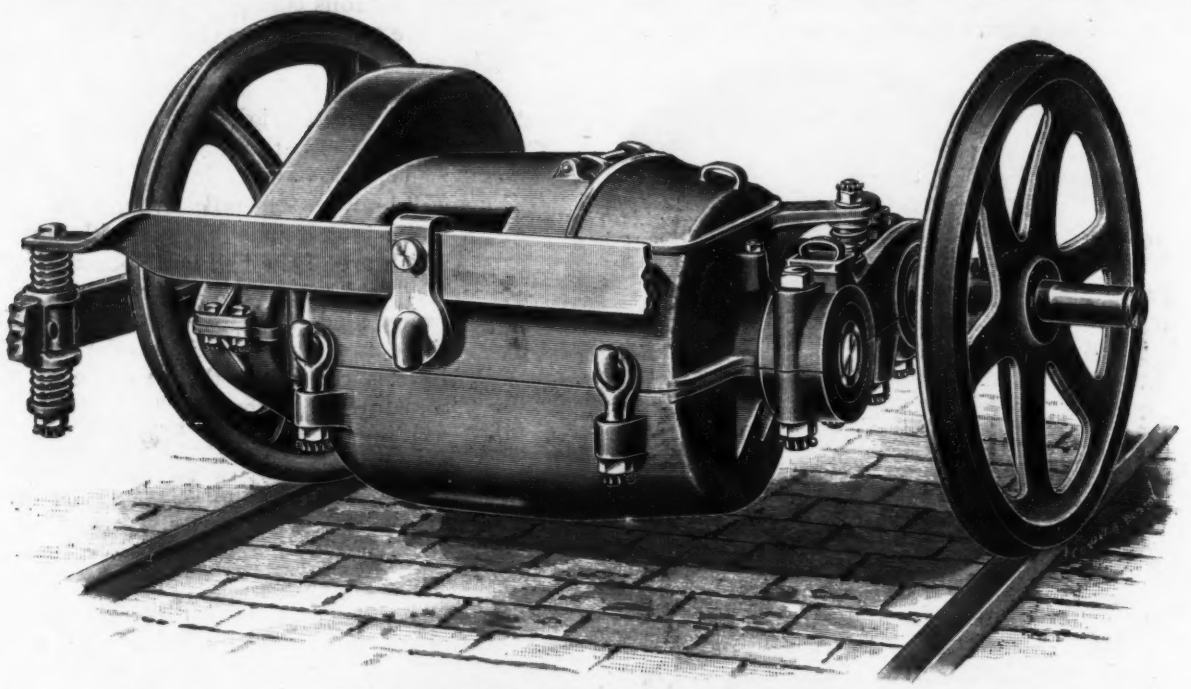
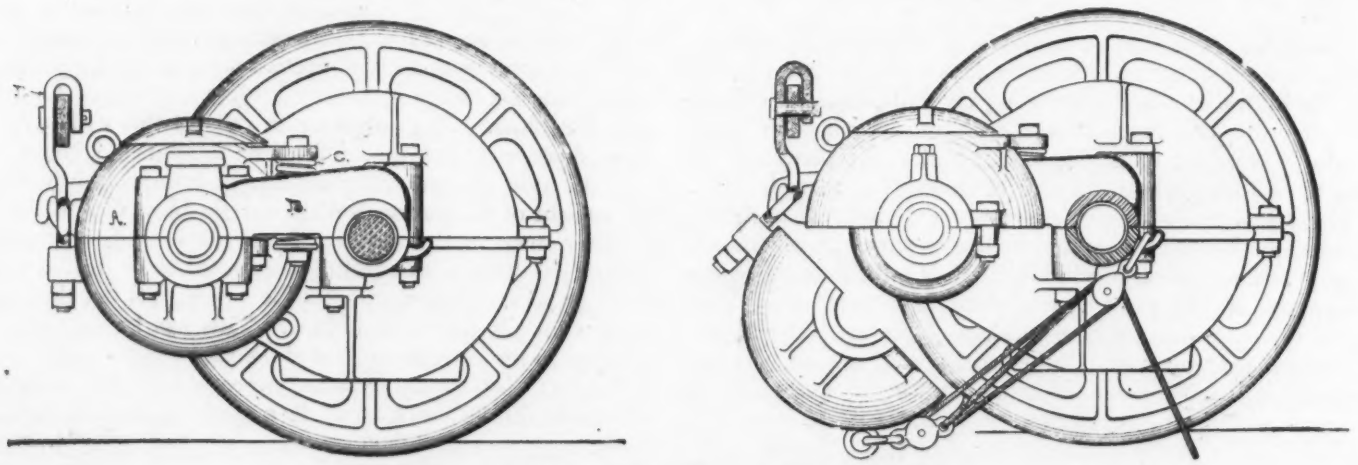


FIG. 2.—SPRING MOUNTED STEEL MOTOR.



FIGS. 3 AND 4.—END ELEVATION OF MOTOR.

Fig. 3 shows an end elevation of the motor with one wheel taken away. *B* is a cast iron U-shaped frame, the rounded end being journaled on the car-axle in the ordinary way. Swinging freely between the arms of this U is the motor, They are solid shells, *A*, filled with the best babbitt and are supported by the bolt, *B*. The grease which comes out between the end of the thrust collar and the inner end of the bearing falls to the ground through the opening, *C*, which is

four inches by two and one-half inches, and cannot be clogged. No grease can get into the motor.

Fig. 6 shows a section of the armature. The core, *A*, is built on a separate sleeve, which receives the shaft, *B*. This shaft, when worn out, can be replaced by removing the nut, *C*, drawing out the shaft and inserting a new one, thus saving the expense of tearing the armature down and rebuilding, as not even a wire connection is disturbed. The

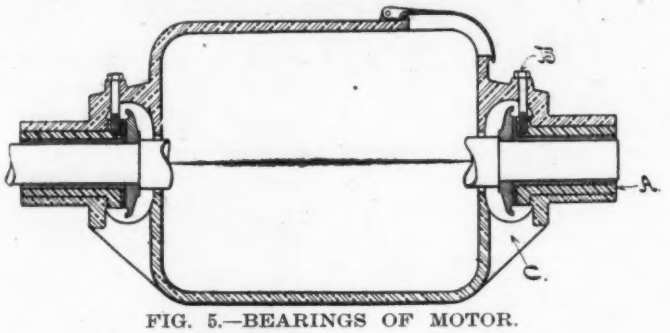


FIG. 5.—BEARINGS OF MOTOR.

commutator is on a tapered portion of the shaft, the same as the pinion, and can be more easily drawn off for refilling. Both commutator and pinion are held in place by nuts properly locked by an ingenious lock washer.

This motor contains all the long-tried constructional points which experience has proven to work well, and the weak points existing in motors of other types have been eliminated. Being flexibly supported, it will remove all trouble with rail joints, as in practice the motor runs as quietly as the old horse car. Not even the gear noise is heard, as the gears as enclosed in airtight housings and run in oil.

A cast iron motor of 35 h. p. weighing 2,500 pounds is also made for heavy work. This motor is intended for heavy street railway work, where very large cars or trains

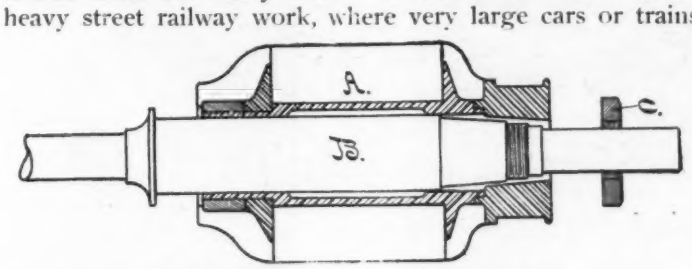


FIG. 6.—SECTION OF ARMATURE.

of cars are used. It is made of cast iron, and has an efficiency of nearly 90 per cent. It is built on the same general type as the steel motor, but is not spring mounted, being journaled on the axle like all other makes. This motor is exceedingly small and light for its output, being of about the same weight as other makes of 25 h. p. capacity. It will operate on 30-inch wheels with plenty of clearance.

The designs are already completed for large motors to operate elevated trains, or suburban and interurban railways, which will be run at high rates of speed. The life and activity which the Walker company is manifesting in entering the market with every kind of electrical machinery required by the large work which is being done and contemplated certainly augurs well for the future. The manufacture under the supervision of those thoroughly familiar with the detail of electrical machinery, and consequent ability to avoid the experimental stage of the business, together with their unsurpassed facilities, assures them success.

Central Station Customers.

The sort of customer for a central station to encourage, says the London "Electrician," is not necessarily the large consumer with his big bill, but the consumer whose bill is large in propostion to the lamps he uses, however small it may be in amount.

A Large Chemical Precipitation Plant.

The largest chemical precipitation plant, and at the same time the largest purification works in operation in this country, is located at Worcester, Mass. Improvements and extensions now nearly completed possess many interesting and unique features. The system is operated on the continuous plan, using lime and iron salts as precipitants. The iron is derived from the sewerage; the lime is stirred in agitators by means of compressed air from one compressor; while a second compressor at another point, operated by a turbine water wheel, driven by purified sewage, lifts the sludge from the ten new tanks to the sludge banks. The turbine water wheel is utilized at night to drive a dynamo, by means of which the whole works, or such parts as are desired, may be brilliantly illuminated.

There are many interesting features brought out in this electric installation. The building where the dynamo is located is 550 feet from the switchboard, so that all its current is delivered to the switchboard, which is made the centre of distribution.

The specifications called for all wiring to be concealed, so that there are no overhead wires above the basins. The main wires are led in wooden conduits, painted with two coats of P. & B. paint. There are three wires in these main conduits, one No. 14 from the rheostat to the field circuit, and two No. 000. The insulation of all the wire which is concealed is the extra heavy white core crown wire, manufactured by the Washburn & Moen Manufacturing Company. On the switchboard is a Carpenter enamel rheostat, a Queen voltmeter, an amperemeter and four single-pole jack-knife switches.

The basins are divided into four circuits, so that in the night-time, before the party who is watching the basins starts out, he can throw on the switch which controls the set of basins which he wishes to inspect. The main wire passes through the switchboard and into the laboratories, where a room is being fitted up in which experiments may be carried on with electricity. The basins are built up of cement with a wrought iron fence surrounding the walks. Each basin has four lights, and the main channel has eight, making sixty-two lights in all over the basins. Each lamp is supported by a fixture which was designed for this purpose, and is shown in Fig. 2. The base of the fixture is of cast iron, through which four bolts pass into the cement to hold the same. The fixture is built up of 2-inch pipe, 3 feet 6 inches long, and is then reduced to 1-inch pipe. Where the 1-inch pipe joins the 2-inch, there is a casting which makes a swinging connection, so that the light may be turned in different positions. There is a thumbscrew which allows the lamp to be held in any position, and a stop to prevent the fixture from turning around and twisting off the wire inside.

Above the 2-inch pipe there is a cross, and a pipe branches out 3 feet, terminating in a cast iron ball. Two feet 3 inches from the upright is an 18-inch double convex shade, from which the lamp hangs. This is supported by braces. The style of the fixture is in keeping with the fence, and makes a very presentable appearance. The feeders for the basin are run in wrought iron pipes. Where the wires from the fixtures connect to the feeders is a cast iron box, which contains a fuse cut-out, so that each lamp is fused.

The cord in the fixture is No. 18 rubber covered, silk lamp cord, covered over with rubber and a second covering of silk, which makes it really a twin cord. Running the wires in the pipes introduced many difficulties, as there were many turns to be made, and a large number of branches. Some of the wire in the pipe is No. 000, and the largest pipe used is 2 1-2 inches in diameter.

One great objection to using a waterwheel with a dynamo has been the unsteady nature of the power which the water-

wheel develops. This objectionable feature, however, was obviated by the use of the Ballard intermediate speed regulator. This regulator is the invention of Mr. H. A. Ballard, and is just being put on the market. It is built by the Columbia Electric Company. The principle is very simple, yet it fills a long felt want in the electrical field, as by its use irregular power may be easily converted into regular power and permit the running of a dynamo. The principle of the regulator is the same as that of a flyball governor. The pressure between two surfaces which have between them some substances, such as leather or vulcanized fibre, is increased or decreased as the speed varies. The regulator is substituted in place of the ordinary dynamo pulley.

The pulley of the regulator runs loose on a sleeve. This sleeve has a flange, which is faced up so that it comes against a corresponding flange of the pulley. Between these flanges is the leather or fibre, which is used as a friction. The pulley runs at a faster speed than the armature of the dynamo. Having adjusted the spring which controls the flyballs (or better, against which the flyballs act), the armature will run at a certain speed, as long as the loose pulley runs faster than the speed at which the armature runs, and it makes no difference how much faster. If the armature tends to speed up, the balls fly out and decrease the pressure between the flanges. The lamps in this installation run without a flicker.

The dynamo used is the "Columbia," which the above company is putting on the market, and with which they are meeting with great success. It has massive cast iron fields, Gramme armature, carbon brushes and self-aligning automatic oiling boxes.

Taking all and all, this makes a very complete and novel isolated plant. All the fittings were designed and built by the Columbia Electric Company at its factory. The design of the fixtures was made by Mr. H. B. Eddy, superintendent of the sewers, who is giving a great deal of attention and study to sewage purification. The details of the electric work were carried on under the supervision of Mr. J. R. Coghlin, general manager of the above company.

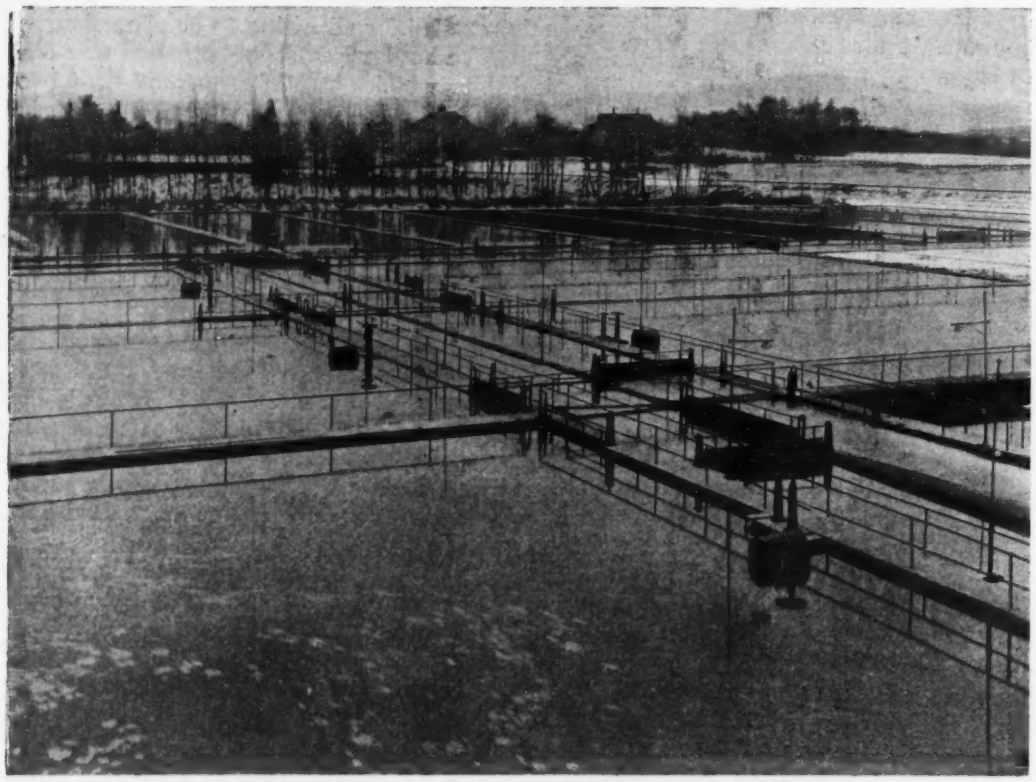


FIG. 1.—GENERAL VIEW OF PRECIPITATING BASINS.

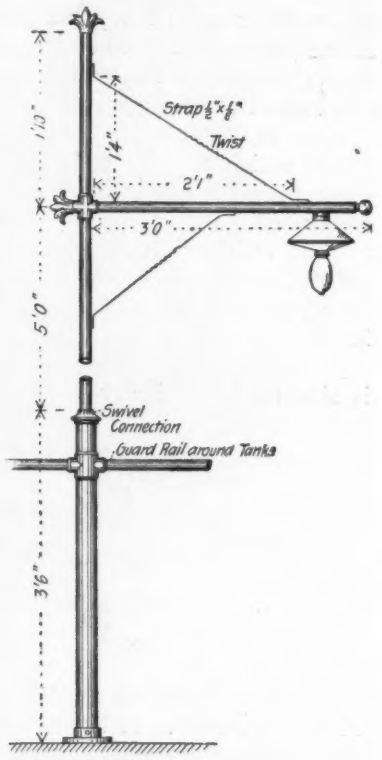


FIG. 2.—LAMP FIXTURE.

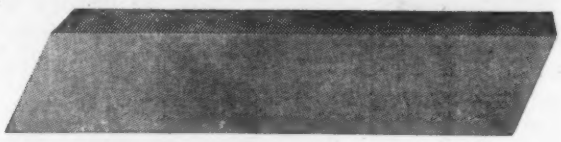
New Feeder Panel, Rubber Covered Wire and Dynamo Brush.

The General Electric Company has recently still further perfected its power house feeder panels. These are made for different numbers of feeder circuits, that known as form "C," adapted for two circuits, being shown in the illustration. It is fitted with a circuit breaker, two ammeters, and two single pole switches. The automatic circuit breaker is known as form "K," and is of the latest and most improved design. It will interrupt repeated short circuits without damage to itself, and can be instantly reset.

The magnetizing coils will carry 1,200 amperes continuously and can be adjusted to 1,800 amperes for temporary overloads. The fuses are of excellent design and can be cheaply and quickly replaced. They are of copper and are coiled to secure some electric magnetic effect and diminish the flashing when melting from overload. The terminals are made with a view to avoid the damage from any ordinary short circuit. These panels are designed to be bolted side by side with the generator panels, and are supported by vertical angle irons which can readily be bolted to the angle irons furnished with the generator panels. The bus bar is of the same height, so that the feeder panels can be connected in circuit by simply extending the line bus bar of the generator panels. Some of the forms of these panels are equipped with circuit breakers and some with fuses. The circuit breaker acts more quickly in opening the circuit, and can be more quickly closed. The fuse acts more slowly, but when blown cannot be replaced as quickly as the circuit breaker can be closed; although the first cost is less, the cost of renewing fuses is greater than of maintaining the circuit breaker.

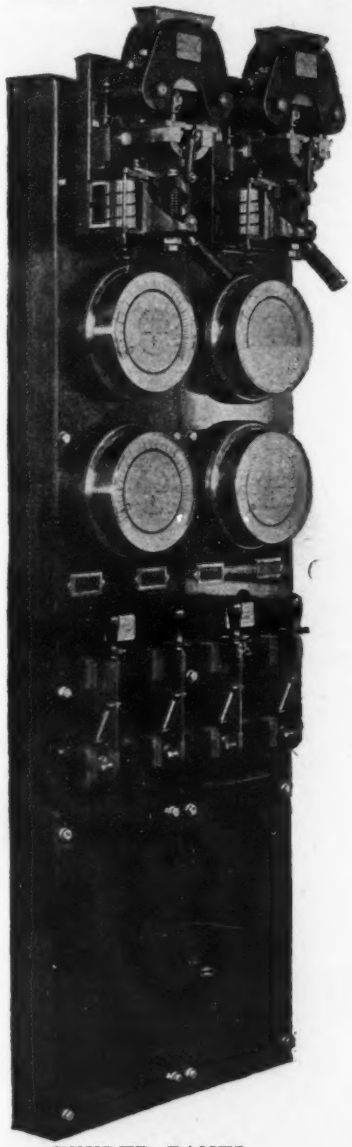
The same company has also just placed upon the market a new rubber covered wire, which is claimed to be superior to anything of the kind yet offered. This is known as the double rubber core wire, and has three coverings. Next to the wire is an inner core of soft rubber, free from sulphur, and protected by a second heavy covering of pure vulcanized rubber. Over this is a braided sheath, finished with

a weatherproof compound which serves to protect the rubber from the attacks of acids, alkalies, and from mechanical injury. Before applying the first covering the copper wire is



WOVEN WIRE DYNAMO BRUSH.

thoroughly tinned to safeguard it from corrosion. The rubber coverings are made of the best grade of fine Para rubber. The wire is made with three standard thicknesses of insulation, although it can be of any thickness desired. The lightest is intended for ordinary electric light wiring and for use on circuits not exceeding 500 volts. The second is for use on circuits not exceeding 2,000 volts, such as street railway, primary circuit alternating, and arc light circuits up to 40 lamps. The thickest insulation is for circuits up to 5,000 volts, and is devised for high tension work. Wire with the last two insulations may be armored for any class of submarine work.



FEEDER PANEL.

Still another improvement is a woven wire dynamo brush, of which they have now ready a complete line for all of the machines they manufacture, Edison bipolar, T.-H. bipolar or multipolar, and, in fact, all, with the exception, of course, of the arc dynamo. The brushes are made of fine wire gauze, which is first wound into rolls, and then shaped into brush form under heavy pressure. They are smooth, give excellent contact, run cool and do not fray.

Polishing and Buffing Lathe.

The machine illustrated, manufactured by the Hanson & Van Winkle Company, Newark, N. J., is designed for heavy work, and fitted with extra long babbited boxes, giving the spindle sufficient bearing to insure stiffness. Without sacrificing strength the width of head has been so reduced that the machine will be found especially desirable by manufacturers of large irregular pieces, and will commend itself to those having bicycle, stove, chandelier, or car trimmings to do, as with this lathe there is no interference when working on large pieces. With this machine a large wheel can be used without the slightest jar or spring. The smallest sizes of these lathes combine all the valuable features of the size illustrated, including tapered steel spindles, etc. The No. 3, of which several hundred are in use, has in addition detachable steel taper ends to take the smallest brush or buff,

POLISHING AND BUFFING LATHE.

and are furnished with tight and loose pulleys, when required. These lathes can be run, it is claimed, at a higher speed than any in the market.

Mast-Arm Pulley.

The lamp supporting pulley brought out several years ago by Mr. George Cutter, of Chicago, has proved so successful for use wherever arc lamps are hung from suspension wires that there has been quite a demand for a mast-arm form of pulley. To meet this, Mr. Cutter has designed the pulley shown in our cut, built on the same general lines as the one for centre suspensions, but with a special clamp, which will fit the iron pipe commonly used on mast arms.

The clamp also serves as a cap for the pipe arm, so that the bracing can be done from this extreme point. All parts are well made and neatly japanned, the snaphook knob (shown only in part by our illustration) being of malleable iron. This knob is automatically guided into its seat when the lamp is raised, and just as readily released, there being no springs, pawls or catches to be clogged by snow or sleet. The lamp supporting feature acts as a perfect safety device, and as the action is automatic the whole ar-

rangement combines the good points of a pivoted mast arm with the simple and rigid design of a fixed form. For this reason alone it will recommend itself to all who are using

MAST-ARM PULLEY.

the rigid mast arms, as well as to those who have not obtained the expected results with the swinging forms.

Electric Track Switch.

We illustrate a new track switch designed by Dr. C. M. Fitch, of South Norwalk, Conn., whose name is well known in connection with this class of street railway devices. The

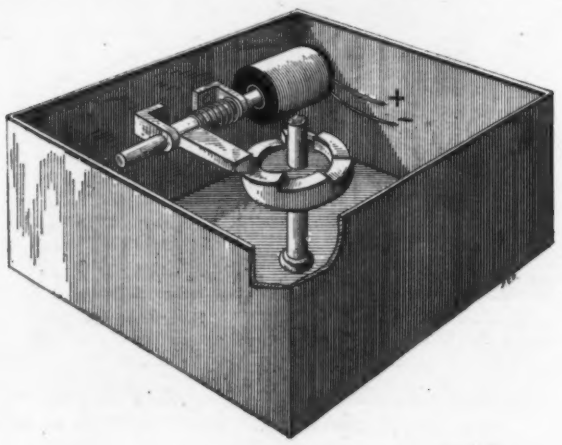


FIG. 1.—ELECTRIC TRACK SWITCH.

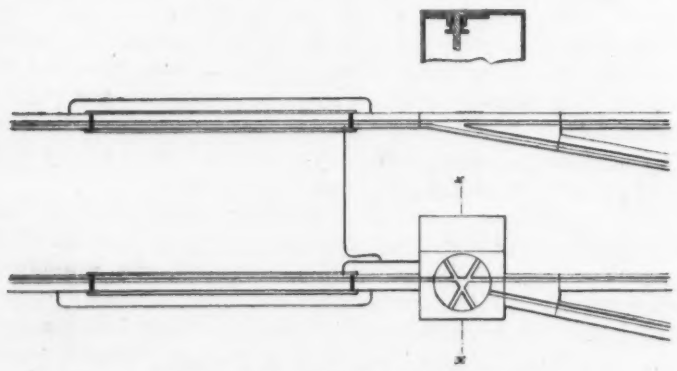


FIG. 2.—ELECTRIC TRACK SWITCH.

apparatus consists of a circular track plate operated by a solenoid in a water and air-tight box. Fig. 1 shows the solenoid, which by means of a ratchet mechanism turns a vertical shaft which, passing through a shifting box, revolves the track plate. An inspection of Fig. 2 will show the manner in which the plate alternately switches on one or the other of the lines. The ratchet teeth are of two lengths so as to provide for the two different angular movements of the plate, corresponding to its two positions.

The solenoid is actuated by the current from the motor car. To accomplish this the parallel rails of the track next to the switch are insulated, and when the car comes on these the current is led to the solenoid, actuating it, and then passes to the ground. Among the advantages claimed are that the switch plate cannot become clogged like the tongue switch and that the mechanism is extremely simple and confined to an air-tight box.

Rheostat Insulation.

We illustrate a new application of micanite insulation, made by the Mica Insulator Company, 218 Water street,

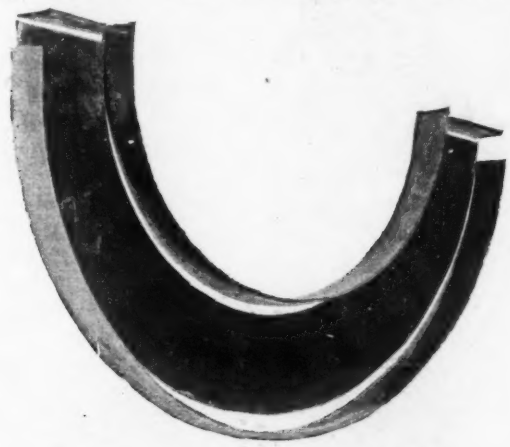


FIG. 1.—RHEOSTAT INSULATION.

New York, for use with rheostat boxes. Fig. 1 shows the micanite lining ready to be put into a box, and Fig. 2 the same in position. Among the other articles made of the

FIG. 2.—RHEOSTAT INSULATION.

same material, recently placed on the market, is a micanite Gramme ring armature spool and a micanite cloth, which is non-absorbtive and has the valuable quality of remaining flexible indefinitely.

Fleming Dynamo Brush.

All who have had practical experience of dynamos will know that if the position of the tips of the brushes as they press on the commutator be not properly adjusted, the result will be "sparking at the brushes." This sparking, if allowed to continue, will sooner or later pit the surface of the commutator segments, destroy their smoothness and even-

ness and heat the brushes. Once started, the mischief goes apace, the commutator becomes untrue and worn into deep and rugged grooves; increased sparking is caused by the "jumping" of the brushes as they pass from segment to segment, and perhaps the tips of the brushes become partially fused, and the commutator is thus gradually eaten

NEW DYNAMO BRUSH.

away until its state is past all remedy. To check the evil it is necessary to continually trim the brush tips, and "true up" the surface of the commutator by trimming it in a lathe, and these often repeated processes result in a greatly reduced life of both commutator and brushes.

All sorts and conditions of brushes have been devised by dynamo manufacturers for this important but somewhat neglected part of a dynamo, such as solid copper plates, bunches of wires, carbon pencils, composite brushes made of several ingredients, etc. The brush that we illustrate, manufactured by the International Trading and Electric Company, 40 Cortlandt street, New York, is of the latest type and should commend itself to the electrical engineer. It is composed of a continuous strip of high conductivity pure lake copper gauze, the copper wire being drawn to 34 B. W. G. and then

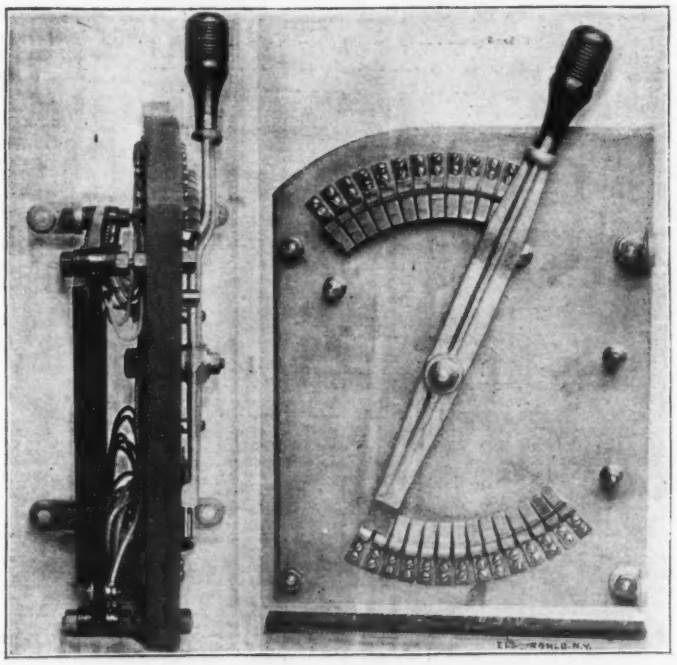


FIG. 1.—50-LIGHT THEATRE DIMMER.

woven to a mesh of 3,600 to the square inch. It is claimed that by this process of manufacturing the Fleming brush, as it is called, an article is produced that when placed on a commutator in good condition is absolutely noiseless and sparkless. The brush is also compact and flexible, readily adjusting itself to the surface of the commutator, ensuring good contact, though bearing lightly and evenly on the segments, and thus reducing to a minimum the wear on this part of the dynamo. This brush, we are informed, has been adopted for use by the United States and other governments.

Compact Rheostats.

The accompanying illustrations show several forms of the rheostats manufactured by the Carpenter Enamel Rheostat Company, of Bridgeport, Conn. The special advantages of these rheostats are their exceedingly compact form and fireproof qualities.

Fig. 1 shows a 50-light theatre dimmer, giving a front

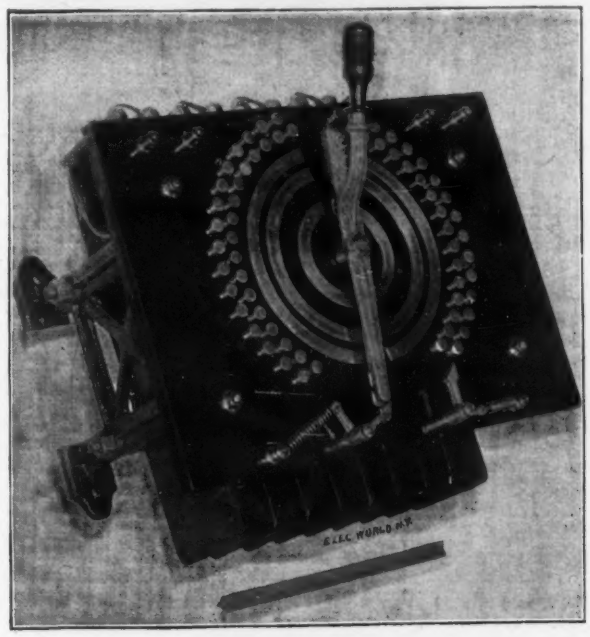


FIG. 2.—REGULATING RHEOSTAT WITH REVERSING SWITCH.

and side elevation. Its small dimensions will readily be seen from the foot rule which lies at the bottom of the rheostat. In the ordinary form of theatre dimmer it has been

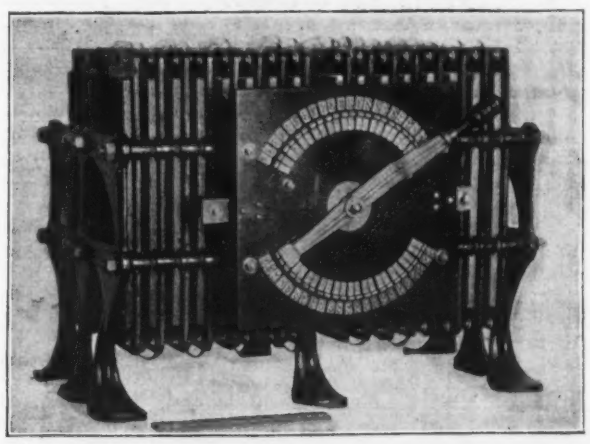


FIG. 3.—MOTOR REGULATING RHEOSTAT.

customary to locate the rheostats coils, often in the form of loose wire, at some distance from the switch, thus not only taking up a great deal of room, but presenting many opportunities for the origin of fire. The Carpenter rheostat is not only exceedingly compact but is absolutely fireproof from the very nature of its construction.

Fig. 2 shows a 10-h. p. 500-volt regulating rheostat with reversing switch. This piece of apparatus was made for the Crocker-Wheeler Electric Company, and embodies the same desirable features as that just described.

In Fig. 3 may be seen a 115-volt motor regulating rheostat made for the C. & C. Electric Company, and shows that the Carpenter form of construction is applicable as well to rheostats which dissipate a large amount of energy as to the smaller sizes.

Financial Intelligence.

The Electrical Stock Market.

New York, April 2, 1894.

GENERAL ELECTRIC, to judge from the weekly record of sales, has completely lost caste with the Stock Exchange fraternity. It was presumed that the near approach of the annual meeting—it will take place at Schenectady on April 10 next—would lead to some spirited dealings in the stock on the generally current and varying rumors regarding the showing likely to be made in the annual report. Strange to say, Wall Street this time—for this week, anyway—has been absolutely free of any gossip regarding the report's figures. Everybody knows now that the report will show a tremendous deficit. It is not well to put this deficit at any given figure, because, in view of the unwillingness of officials to furnish a forecast of the report, such a calculation would be the merest and boldest kind of guesswork. It is to be hoped that the management will feel constrained to make a frank and open avowal of the General Electric Company's condition. The coming control of the property is still a matter of much discussion. It is an open secret that the Vanderbilt interests hold by far the greater portion of the capital stock. It was on the cards all along that Mr. H. McKay Twombley, who is Mr. Cornelius Vanderbilt's brother-in-law, or some other close connection of the family, would prove Mr. Coffin's successor as president of the General Electric Company. Latterly, however, there has been a remarkable reconciliation of inside quarrels, and it would not be surprising, now, if the whole original programme were abandoned and President Coffin and his associates be allowed to hold over another year. That all faith has not been lost in the property is shown by the purchase this week of the General Electric 5 per cent. debenture bonds. The feature of the financial week has been the heavy investment demand for bargains in bonds, and General Electric debentures, with other good and cheap issues, have been picked up with avidity. A confirmation of official reports of increased business is had in the announcement that seven orders have recently been received by the General Electric Company from Southern states for lighting plants requiring 3,000 arc and 1,700 incandescent lamps.

WESTINGHOUSE ELECTRIC ISSUES have been neglected in Boston as much as General Electric stocks were let alone here. Current talk relates mostly to big earnings, and, under these favorable influences, both the preferred and common shares have been very strong. Thus it is stated that the net earnings of the Westinghouse Electric Company for January were between $125,000 and $150,000, or at the rate of over 15 per cent. per annum on the company's total capitalization. It is also learned that the Westinghouse company's accounts made up to April 1, with March partly estimated, show, after allowing for the dividend on the preferred stock, and after charging off $400,000, a balance of $233,000, there being also a decrease in bills payable for the year of $964,000. At this rate dividends on the common stock are no dream, and it is no wonder that so little of the stock appears in open market.

WESTERN UNION TELEGRAPH stock is dormant again. The bears have been making comparisons of late, and insist that the stock is selling too high. Thus, they say that Chicago, Burlington and Quincy is as sure a 5 per cent. dividend payer as Western Union, yet the latter stock sells many points higher, though it is subject to reflect every bad feature of the business situation, earning dividends only when times are prosperous, and drawing upon reserves when commercial affairs are not all they should be. There is no likelihood, however, of Western Union or "Telegraph," as the Street knows it, receding very much. While it is not worth, perhaps, intrinsically more than Burlington, nevertheless it is so generally distributed and well held that it is almost impossible to bring about any decided fluctuation with the limited amount of stock in the market.

AMERICAN BELL TELEPHONE has been the only electric stock to show any activity this week, and the strength it has developed has been due to the fine showing made by the annual report made public at the stockholders' meeting, on Tuesday of this week. The annual report is very full and covers all details of operation. Gross earnings in 1893, from all sources, were $5,781,076; expenses were $1,855,591, and net earnings $3,925,485, or $513,811 more than in 1892, despite the prevailing commercial distress. The 1892 increase over 1891 was $284,855; 1891 over 1890 was $257,402. It paid $420,066 more in dividends, $3,339,156 in all, than in 1892, owing to increased stock, but the surplus of $586,530 was $93,745 greater; hence reserve for depreciation was increased correspondingly, the company maintaining its accummulating surplus at $2,151,012 as in preceding years. The increase in net is equivalent to 15.05 per cent., where, except in 1887, when it was 13.3 per cent., the annual increase has ranged from 7.8 per cent. to 9.25 per cent. Evidently the new stock issued in 1893 enabled the company to increase its earning power through extensions of its business. It is pointed out in the annual report that an increase in 1894 of less than 9 per cent. will permit of the payment of 18 per cent. on the whole $20,000,000 stock. Such an increase would give net earnings of $3,718,725, while 18-per cent. dividends call for only $3,600,000. If a 15-per cent. gain was made in a bad year, as 1893 was, a 9-per cent. gain can be easily reckoned upon in ordinary times.

THE MEXICAN TELEGRAPH COMPANY has declared a quarterly dividend of 2½ per cent. out of its net earnings to March 31. The surplus earnings for the quarter, after providing for this dividend, are $18,376. The estimated operations for the quarter show a net income of $66,191, and a total surplus of $373,246.

THE CENTRAL AND SOUTH AMERICAN TELEGRAPH COMPANY has declared a quarterly dividend of 1¾ per cent. out of its net income for the quarter ended March 31, estimated at $142,260. There is a surplus for the quarter of $31,870, and a total surplus on March 31 of $529,657. The net receipts for the years 1893 were $555,075. This sum would have been sufficient to have paid 7 per cent. on the outstanding share capital, $6,308,000, and also on $1,417,600 duplicate cable certificates had they been converted into stock, and yet left a surplus of $18,283. The receipts for the current quarter will exceed those of the corresponding quarter of 1893 about $6,000.

EDISON ELECTRIC ILLUMINATING of New York displays no change in quotation. The Stock Exchange this week listed $750,000 first mortgage 5s, making the total now listed $4,312,000. This issue of bonds was authorized last November, the proceeds to be used for construction purposes; they are convertible into common stock at par up to July 21, 1895.

THE STREET RAILWAY AND ILLUMINATING PROPERTIES TRUST, the company organized on a lot of treasury assets of the General Electric Company, has set aside another $200,000 for the purchase of preferred stock, proposals for the sale of the same to be received up to April 2. A $10,000 subscription to the company was this week offered at 92.

THE NEW ENGLAND TELEPHONE COMPANY has declared a regular quarterly dividend of ¾ per cent., payable March 15.

THE NEW YORK AND NEW JERSEY TELEPHONE COMPANY earned in 1893, it is reported, $367,375 net over all charges, or 14 per cent. on the stock. Dividends of 6 per cent. were paid, and the balance was carried to the surplus, which now amounts to 30 per cent. on the stock.

THE HOLTZER-CABOT ELECTRIC COMPANY, of Boston, has declared a quarterly dividend of 2 per cent., payable April 2.

THE EDISON ELECTRIC ILLUMINATING COMPANY, of Brooklyn, will soon issue $500,000 new stock for the purpose of increasing its plant.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Brush Ill., New York	50	20	35
Detroit Electrical Works	10	2	3
Cleveland General Electric Co	—	85	90
East River Electric Light	100	—	65
Electric Con. & Supply Co., pref.	15	15	16
" " " com.	15	15	17½
Edison Electric Ill., New York	100	98½	99½
" " " 1sts	—	105	105¼
Edison Electric Ill., Brooklyn	100	102	105
" " " Boston	100	115	120
" " " Chicago	100	125	130
" " " Philadelphia	100	130	132
Edison Electric Light of Europe	—	—	3
" Bonds	—	80	85
" Ore Milling	—	10	11
Fort Wayne Electric	—	4½	6½
General Electric Company	100	42½	42¾
" " " deb. 5's	—	83½	84
Interior Conduit and Ins. Co	100	20	30
Mount Morris Electric	—	—	65
Westinghouse Consolidated	50	32	33
" " " pref.	50	49	50
Western Union Telegraph	—	85⅜	85½
American Bell Telephone	—	189¾	190

New Incorporations.

THE CAYUGA LAKE ELECTRIC RAILWAY COMPANY, Ithaca, N. Y., capital stock $25,000, has been formed to operate a railway. D. F. Van Vleet, H. Hergholtz, Ithaca, and A. Hond, Scranton, Pa., are the promoters.

THE FALLS ELECTRIC LIGHT COMPANY, Williamsport, Ind., capital stock $6,000, has been formed to supply electric lights, etc. L. Swank, W. C. Smith, A. H. Hann and C. V. McAdams, Williamsport, Ind., are the promoters.

THE COLLYER INSULATED WIRE COMPANY, Hopedale, Mass., capital stock $24,000, has been formed to manufacture and sell wire and electrical apparatus. Mr. W. F. Draper, C. E. Bowen and F. J. Dutcher are the incorporators.

THE ELECTRIC HEATING AND COOKING COMPANY, Baltimore, Md., maximum capital $100,000, has been formed to manufacture, operate, etc., appliances for heating and cooking by electricity. G. H. Whittinsham, C. K. Harrison and E. Hammond, all of Baltimore, are the promoters.

THE MONTCLAIR ELECTRIC LIGHT COMPANY, Montclair, N. J., capital stock $50,000, has been formed to manufacture and use electricity for producing light, heat and power. The incorporators are P. Wilcox, T. G. Sullivan, J. A. Ryan, W. L. Ludlam and C. A. Dutchines, of Montclair, N. J.

THE GALLIPOLIS ELECTRIC LIGHT AND POWER COMPANY, Gallipolis, Ohio, capital stock $18,000, has been formed to

generate electricity, manufacture and furnish electric light, power, etc. A. J. Greene, F. E. Mohr, J. W. Clendenin, H. B. Summers and Julia C. Greene are the incorporators.

THE AMERICAN DISTRICT TELEGRAPH COMPANY, San Antonio, Tex., capital stock $3,000, has been formed to operate a system of district telegraph and telephones and do all kinds of electrical work, etc. B. F. Kingsley, C. M. Kingsley, San Antonio, Tex., and C. K. Meade, Des Moines, Iowa, are interested.

THE ST. GENEVIEVE BREWING AND LIGHTING COMPANY, St. Genevieve, Mo., capital stock $30,000, has been formed to manufacture and generate electricity for light and power, also to manufacture beer, supply cold storage, etc. H. J. Rosier, W. W. Wilder and Valentine Rottler, of that city, are the interested parties.

THE HUNTSVILLE ELECTRIC LIGHT AND ICE COMPANY, Huntsville, Tex., capital stock $6,500, has been formed to generate and sell electricity, furnish cold storage, etc. T. H. Hall, J. G. Ashford, T. C. Gibbs, C. G. Barrett, R. S. Rather, J. W. Thomason, C. H. Robinson, H. A. Eastham and W. S. Gibbs are the incorporators.

THE NEW YORK AND EASTERN TELEGRAPH AND TELEPHONE COMPANY, Jersey City, N. J., capital stock $140,000, has been formed to construct and maintain telegraph and telephone lines, etc. W. J. Griffith, 135 West 49th street, H. Morris, 430 East 22d street, New York City; E. M. Millard, 468 Willoughby avenue, James Ross, 792 Carroll street, J. B. Skinner, 241 Hancock street, and A. Noden, 176 York street, Brooklyn, N. Y., and W. S. Rich, 938 13th avenue, Newark, N. J., are the incorporators.

Special Correspondence.

New York Notes.

OFFICE OF THE ELECTRICAL WORLD,
41 Park Row NEW YORK, April 2, 1894.

J. JONES & SON, 39 Vesey street, New York, report that they have been taking recently some heavy orders for their anti-thunder bolt paper.

Mr. B. E. DAVIS, agent for the specialties manufactured by Messrs. Pass & Seymour, Syracuse, N. Y., was in town last week and reports having had a successful trip throughout New England.

MR. EDWARD J. DALTON, manager of the New York office for M. T. Davidson, reports that his firm has recently completed 18 brass end steam pumps for use aboard the United States war vessels.

EUGENE MUNSELL & CO., 218 Water street, New York City, would be pleased to hear from their customers over the telephone. Their number is 968 Cortlandt. All communications through this source will receive prompt attention.

THE BALL & WOOD COMPANY on Saturday afternoon entertained about 500 mechanical and electrical engineers, who visited its works at Elizabethport, N. J., in response to an invitation to view a new type of compound vertical engine. It is only at the annual or other extraordinary meetings of the professional societies that such a distinguished body of men can be seen assembled, and it speaks most highly for the professional and personal reputations of Messrs. Ball & Wood that their invitation was, apparently, almost unanimously accepted. Every preparation had been made to render the visit agreeable; the main offices were temporarily transformed into a lunch room, where also two huge punch bowls occupied positions of honor, and received due attention from the visitors. Among those in attendance were an ex-engineer-in-chief of the navy, several ex-presidents of the Am. Soc. of Mech. Eng. and so many others of prominence that even a partial list would be too large for the space at our command. We shall describe the engine fully in a future issue, and now merely note that its peculiarity consists in an unusually ingenious valve gear. The exhaust valves and main steam valve are of the Corliss type, and driven from a vibrating disc like Corliss valves; the cut-off valve is within the main valve, and receives a motion which is the resultant of that of the main valve-driving disc, and of the motion from a wheel governor similar to the one used on the ordinary type of the Ball & Wood engine.

New England Notes.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., March 24, 1894.

WARREN, MASS.—Voters will be asked at a town meeting to allow the Palmer & Monson Electric Light Company to erect poles and string wires.

ISLEBORO, ME.—Captain Winfield Pendleton, of Isleboro, states that his proposed telegraph and telephone line from Isleboro to Belfast and Northport will not be built this year, but that it ultimately will.

THE CITY COUNCIL of Boston is to consider a report from a sub-committee recommending an expenditure of $15,000 to provide for the employment of electrical experts in the several fire districts. The idea is to give the fire department the benefit of all the scientific and practical information for use in its daily work, and in emergencies.

THE PROPOSED SUBWAY in Boston is seemingly not gaining friends, and more opposition is developing each day. It does not seem to strike a popular chord, and many of those who have studied the matter feel that the final result will not be entirely what is hoped for, namely, a complete relief of the congested districts. The matter is still under discussion by proper authorities.

THE MATHER ELECTRIC COMPANY, Manchester, Conn., informs us, through its secretary, that Messrs. Angier & Co. are its authorized representatives in Boston and vicinity. The company has no other representative in Boston, and this is to correct the announcement recently made to that effect. Mr. Angier is well known in the electrical field, having been for a long time connected with the firm of Claflin & Kimball, 116 Bedford street, Boston, Mass.

Pittsburgh Notes.

PITTSBURGH, March 31, 1894

THE SECOND AVENUE TRACTION COMPANY of this city has decided to operate an electric launch on the Monongahela River, between Glenwood and Homestead.

GENTLEMEN INTERESTED in the Creighton, Kensington and Parnassus Electric Street Railway have asked for a charter to build a bridge across the Allegheny River at Creighton. The bridge will be used in connection with the electric road.

THE AMERICAN TELEGRAPH AND TELEPHONE COMPANY has been organized in Brushton, and has asked the Borough Council for the right to string wires, and will commence operations immediately. Brushton is a town about six miles from Pittsburgh.

BUILDING on the new works of the Westinghouse Electric and Manufacturing Company, at Brinton, is rapidly progressing. The foundation of the immense machine shop is almost completed, and the putting up of the walls of the structure is commencing.

THE ALLEGHENY CITY electric light plant has recently greatly increased its capacity of arc lights. For a number of years the company has been using the tower light system, but it was not long ago decided to take these towers down and substitute them with mast arm lights.

IT MAY BE INTERESTING to the electrical trade to learn that all of those companies in this city which are known as "the Westinghouse interests" are dividend-paying investments. These companies are capitalized in round figures at $30,000,000, comprising the following: The Westinghouse Air Brake Company, the Westinghouse Electric and Manufacturing Company, the Standard Underground Cable Company, the Union Switch and Signal Company, the Allegheny County Light Company, the Westinghouse Machine Company, the Philadelphia Company and the Allegheny Heating Company.

News of the Week.

Telegraph and Telephone.

TOPEKA, KAN.—The Topeka-Harrison Telephone Company has applied for a franchise to construct and operate a telephone line. S. J. Bear and A. K. Rodgers are interested.

WISCASSET, ME.—A telephone company has been organized at Wiscasset by Joseph P. Tucker, A. S. Erskine and F. A. Creamer. The system will be put up and operated this spring.

THE HARRISON INTERNATIONAL TELEPHONE COMPANY has secured handsome offices at 44 and 46 Wall street, New York. This company is organized under the laws of Illinois with a capital of $80,000,000, and the following well known gentlemen as officers and directors: President, Stephen B. Elkins; secretary, Patrick Egan; vice president, C. M. Ferree; general manager, H. J. Hanford; directors, R. C. Kerens, George R. Peck, T. J. Hurley, Robert P. Porter, William Warner, L. E. Ingalls, H. M. Holden, A. L. Stone, Stephen B. Elkins, C. M. Ferree and the chief electrician, Dr. E. M. Harrison.

Electric Light and Power.

DURAND, WIS., is considering electric lighting.

SHELDON, ILL., will vote in April on a bond issue for electric lights.

ELKHORN, WIS.—Residents of Elkhorn are asking for electric street lighting.

OSCEOLA, IOWA.—An electric light plant will be put in during the coming year.

NORWICH, N. Y.—The Norwich Illuminating Company proposes to reconstruct its electric light plant.

MARBLEHEAD, MASS.—Marblehead has voted to establish an electric light plant at a cost of $60,000.

DENVER, COL.—The county commissioners will consider plans for an independent plant for lighting the court house.

FREELAND, PA.—The Freeland Light, Heat and Power Company has been granted a contract to light the borough of Freeland.

GENESEO, N. Y.—The village trustees of Geneseo have decided to try electric lighting, and they will advertise for bids this week.

CHATHAM CENTRE, N. Y.—H. C. Spengler intends putting up a good-sized electric lighting plant in Chatham to furnish the village with lights.

CHARLOTTE, N. C.—The Charlotte Consolidated Construction Company is in the market for two alternating light machines and necessary apparatus.

WOODBURY, N. J.—Solicitors are now seeking subscribers in Woodbury, Clayton, Glassboro and Wenonah for electric light plants, which a syndicate of capitalists proposes to erect.

RICHMOND, VA.—In the matter of the resolution to appropriate $75,000 for a municipal electric light plant, it was decided to send same to committee on light for estimates and report.

PHILADELPHIA, PA.—The sub-committee of Councils, electrical committee, to which has been referred the matter of a city electrical plant, has reported adversely on economical grounds.

CLEVELAND, OHIO.—The repair shop of the Cleveland Electric Company was burned to the ground March 24. All the valuable machinery, including several motors, was burned. Loss $50,000, insured.

MEMPHIS, MO.—A contract has been closed with the Franklin Electric Company, Kansas City, Mo., for an incandescent electric lighting plant including new steam plant and Edison incandescent dynamo and construction.

FALL RIVER, MASS.—It is stated that the Edison Illuminating Company will build an addition to their plant on Hartwell street, and will put in a compound engine of 400 h. p. with direct attachment to the dynamo.

LEAVENWORTH, KAN.—It is proposed to erect an electric fountain at the Soldiers' Home when the electric railway is extended there. It will cost $50,000, to be defrayed by the Home, the city and the railway company.

WASHINGTON, D. C.—Sealed proposals will be received at the office of the commissioners of the district to 2 P. M., April 12, for furnishing 225 lamp posts. J. W. Ross, Geo. Truesdell and C. F. Powell are the commissioners.

VALPARAISO, IND.—The City Council is considering the establishment of an electric light plant, the present plant being insufficient in size to be an incandescent system, and it is also considering more street lights and telephones.

EVANSTON, ILL.—The Council committee on lighting recommended that the Evanston Electric Illuminating Company put in a 50-light machine in the city's plant at South Evanston, and that new lights be put at various parts of the city.

ERIE, PA.—The Common Council has finally passed the ordinance granting permission to the Merchants and Manufacturers' Electric Light Company to string wires and erect poles in certain streets for the purpose of supplying light and power.

SAVANNAH, GA.—The Council has decided that it is inadvisable that Savannah should purchase and operate a municipal electric light plant at present, and a contract has been awarded to the Brush Electric Light Company for three years.

ST. LOUIS, MO.—The Subway Commission has requested City Electrician Andrew J. O'Reilly to make plans and specifications for a conduit system to extend from Cass avenue to Choteau avenue and from 20th street to the river, to include a number of ducts.

WASHINGTON, D. C.—Senator McPherson and Mr. Cadmus have introduced bills incorporating a company of New York and New Jersey capitalists, who propose to supply electric light for the streets of Washington, in competition with the Washington Gas Light Company.

SAVANNAH, GA.—Plans are ready for a complete new station to be built by the Brush company. Building will commence at once, and the plant will be completed and ready by Oct. 1, 1894. The company has all it needs in electric machinery, but will install new boilers and condensing engines.

The Electric Railway.

DAYTON, OHIO.—The City Street Railway will erect a brick power house on Emily street.

AUSTIN, TEX.—E. J. Burns, of Dallas, Tex., has bought the Austin dummy line, and the motive power will be changed to electricity.

WAVERLY, PA.—Bids for the buildings and power house of the Waverly, Sayre and Athens Street Railway have all been rejected, and the work will be done by the day.

CHICOPEE, MASS.—The Chicopee aldermen have given a hearing to the petitioners of the Wymanlea Electric Railway Company, and voted to lay the matter on the table.

ASBURY PARK, N. J.—It is proposed by the Seashore Traction Company to build an electric railway from Asbury Park to Pleasure Bay, to connect with steamers to New York.

DARTMOUTH, MASS.—The contract for building the Dartmouth and Westport Electric Railway has been awarded to Arthur Hodges, of Boston; the road is to be ready June 20.

ALBION, N. Y.—Over $50,000 of the $60,000 required has been subscribed towards the road which Emmons, Dwyer & Co., of Syracuse, propose to build from Batavia to Oak Orchard.

LOCKPORT, N. Y.—W. C. Reed, of the Lock City Electric Railroad construction force, states that the work of getting options for the Williamsville-Lockport railway is almost completed.

NORWALK, OHIO.—The Sandusky, Milan and Norwalk Electric Railway Company will sell the remainder of the $16,500 in bonds to extend the line in Norwalk to the city limits, work to begin at once.

LOCKHAVEN, PA.—The proposed electric railway is now a certainty, the sum of $10,000 having been subscribed. The following are the committtee to organize a company: W. H. Mayer, L. M. Patterson and T. H. Harmon.

ALLENTOWN, PA.—The Eastern Transit Company has decided to extend its lines to Chain Dam, and the contract has been awarded to the Lehigh Valley Construction Company, of which H. O. Duerr is manager, at Bethlehem, Pa.

PITTSBURGH, PA.—Longfellow, Alden & Harlow, of 6 Beacon street, Boston, Mass., have made plans for the proposed power house, to be known as the Vandegrift Power Building, to be located at Penn avenue and Third street.

JACKSONVILLE, FLA.—The Jacksonville Street Railway Company has advertised for bids for furnishing electric power for the lines of the company, and they are now being received. J. E. Hartridge is general council to the company.

BALTIMORE, MD.—The Piedmont Construction Company, in which many prominent Baltimore capitalists are interested, has secured a desirable site for the power house for the electric railway at Charlottesville, the construction of which will soon begin.

ITHACA, N. Y.—The Cayuga Lake Electric Railway Company, capital stock $25,000, has been chartered at Albany to build a road from Percyfield, on the lake road, Ithaca, to the southeast corner of Cayuga Lake. Alfred Hand, Horace E. Hand and E. L. Fuller, of Scranton, Pa., are interested.

BALTIMORE, MD.—The Legislature has passed the bill incorporating the Columbia and Maryland Railroad Company to build an electric or other railway from Baltimore to Washington and other points. Stephen Gambrill, brother-in-law of Senator Gorman, is one of the incorporators.

SOUTHINGTON, CONN.—Engineer T. H. McKenzie, of Southington, has been engaged by the Bristol-Plainville Tramway Company to make a survey of the proposed line from Bristol to Plainville, thence to Compounce Lake. Residents of Southington are urging that the road be extended to their town.

HOOSICK FALLS, N. Y.—The Hoosick Railway Company has made an application to the Highway Commission for permission to build and operate an electric railway on the highway leading from Hoosick Falls to and through North Hoosick and Wallcomsac. The petition will be heard at public meeting April 6.

SAVANNAH, GA.—The reported consolidation of the electric street railways has not taken place, and it is not probable it will be done for the present. The terms offered by Mr. J. S. Collins, president of the Electric Railway of Savannah, were not satisfactory to Mr. Parsons, of the Savannah Street Railway.

BOSTON, MASS.—The Magnetic Electric Railway Company, of Boston, is holding meetings in Portland, Me., with the object of perfecting arrangements to build and operate a new system of electric railway, invented by Edward H. Brown, of Salem, Mass. L. G. Burnham, H. W. Peabody and C. E. Hubbard, all of Boston, Mass., are interested.

CHESTER, PA.—Colonel Samuel A. Dyer, president of the Union Railway Company, of Chester, has bought a controlling interest in the stock of the Chester, Union, Chester and Media, and the Chester, Darby and Philadelphia railways, and he will form them into one company, to be known as the Chester Traction Company, and make important improvements and extensions.

AN IMPORTANT SUIT.—The case of the Adams Electric Company vs. the Lindell Railway Company will be heard before Judge Hallett, in St. Louis, on April 20. This is the well known case involving the alleged infringement of the method of centring an electric motor over an axle. Dr. Wellington Adams claims to be the inventor of this "method," and Colonel Hill, Ex-Governor D. R. Francis, Congressman Seth W. Cobb, Major C. C. Rainwater, Judge

Given Campbell and Prof. Francis E. Nipher and other prominent citizens of St. Louis are interested. The winning of the suit by the Adams company would involve the question of a royalty to be paid by all electric railway companies.

Personal Notes.

MR. JAMES H. RHOTEHAMEL was married on Tuesday, March 28, at Chicago, to Miss Nancy Rex. Mr. Rhotehamel is president of the Columbia Incandescent Lamp Company, of St. Louis, and is widely known and very popular in the electrical field. We feel sure that their many friends will join us in extending best wishes to the happy couple.

Miscellaneous Notes.

AN ELECTRICAL GOAT.—Mr. G. Wilfred Pearce contributes an amusing account to a New Jersey newspaper of a goat named Home Rule, attached to the Edison laboratory and lamp works, which in return for its food from the hay and excelsior packing bins renders faithful and prompt service in butting over book agents, lightning rod men and English tourists, who visit the factory for the purpose of taking up the time of Wizard Edison. Home Rule has, like a well conducted policeman, a beat, which he patrols with unfailing regularity. It commences early in the morning at the lamp works, and extends to the Pennsylvania depot, where he welcomes the New Brunswick contingent; after that he keeps on to the Delaware depot to welcome Edison and others, and woe betide the great inventor if he has failed to put a store of peanuts in his hat for Home Rule. That happened not long ago, but Home Rule "got square" by chewing up the Wizard's new Dunlap silk hat and book of tickets on the railroad. This remarkable goat, we are informed, cares not a whit for poisons or the powerful currents of electricity. It is an unusual day when he does not drink a gallon of battery solution, or chew up a yard of live electric wire in the lamp factory.

Trade and Industrial Notes

THE LAW BATTERY COMPANY, 85 John street, New York, is presenting to its friends and patrons a novelty in the form of a glass pen to be used as a steel pen.

THE HORN, BRANNEN & FORSYTH MANUFACTURING COMPANY, Philadelphia, received the contract for supplying combination gas and electric fixtures for the new Federal building at Troy.

CHARLES PLUMB, 89 Erie street, Buffalo, has invented and constructed an accumulating influence machine for medical purposes, particularly for the treatment of rheumatism and nervous affections.

THE OHIO BRASS COMPANY, Mansfield, Ohio, reports that it is receiving satisfactory results from its new catalogue, and that the general favor with which its manufactures are received are most gratifying.

THE CHICAGO INSULATED WIRE COMPANY, 207 South Canal street, Chicago, Ill., is finding a strong demand for insulated wire, which it manufactures in all varieties, as well as its special lamp coil.

THE ROWELL & CHASE COMPANY, 1217 Union avenue, Kansas City, Mo., has opened a branch office of the Sioux City Engine and Iron Works, and will handle a full line of the goods in addition to that of many other houses.

THE SHERBORNE ELECTRIC INSTALLATION, Sherborne, Dorset, England, sends us circulars descriptive of the Sherborne combination gas engines and dynamos, and of omnibus and bicycle storage batteries and electric lamps.

W. H. STANLEY has leased the premises of 806 Walnut street, Philadelphia, lately occupied by O. D. Pierce & Co., where he intends to keep on hand a large assortment of electrical supplies and also carry on the electrical construction business.

THE STROWGER AUTOMATIC TELEPHONE EXCHANGE, of Chicago, has ordered 100 No. 1 standard magneto telephones from the Western Telephone Construction Company, of Chicago, to replace the battery telephones of the exchange at La Porte, Ind.

THE SHORT ELECTRIC RAILWAY COMPANY held its annual meeting on March 27. The old board of directors was re-elected, and the following officers chosen: President, B. F. Miles; secretary and treasurer, Bethune Duffield, Detroit, Mich.; general manager, S. M. Hamill.

THE BEACON VACUUM PUMP AND ELECTRICAL COMPANY, Boston, has made a reduction in the price of the "New Beacon" lamp. The great advances made in the improved lamp have resulted in such a greatly increased output that it has been possible to make the reduction referred to.

THE "I. X. L." TEMPERED COPPER COMPANY, Buffalo, N. Y., has removed its office and works from 226 Ohio street to 132 Niagara street. The material sold by this company is guaranteed pure unalloyed copper, and has been tested and tried by many of the largest electrical houses in the country, from whom some very flattering testimonials have been received.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY has issued another of the handsome technical monographs for which it is noted, the present one being devoted to the Wurts non-arcing railway lightning arrester. The descriptions are largely written from a technical rather than a commercial standpoint, and illustrated with a number of good engravings.

THE HYDRAULIC MACHINERY WORKS, 204 E. 43d street, New York, has had printed on cardboard, to be hung up in the workshops, "Points well worth remembering," in regard to hydraulic jacks, directions under 18 heads being given for their use and repair. The same company has also issued two catalogues, one being devoted to hydraulic jacks and the other to punches and shears.

THE NATIONAL TELEPHONE MANUFACTURING COMPANY, 620 Atlantic avenue, Boston, Mass., has just produced a new magneto telephone, which, it is predicted, will prove very popular. It will be remembered that this company produced a very fine mechanical telephone, and the success of that instrument augurs well for the one which it has just brought out.

THE BISHOP GUTTA-PERCHA COMPANY has issued a 42-page pamphlet entitled "Tables, Rules and Information for Architects and Electrical Engineers," which contains wiring tables for 50 and 100-volt lamps, full data in regard to the celebrated Bishop white core wires, a copper wire table and the New York Board of Fire Underwriters' rules for safe wiring, to which a useful index has been added.

THE HART & HEGEMAN MANUFACTURING COMPANY, of Hartford, Conn., is now comfortably located in its new home at 26 High street, that city, where it posseses abundant facilities for the manufacture of its well known electrical specialties and the transaction generally of its rapidly increasing business. Manager Pease has a thoroughly satisfied look for everybody and everything in his new abode.

THE BUCKEYE ELECTRIC COMPANY, Cleveland, Ohio, has issued two circulars describing its new special lamp and new railway lamp. The former is but 4½ inches long, the standard type being 5½ inches, and its neat and compact shape makes it particularly convenient for steamer and household lighting. The railway lamp has an anchored filament, and is uniform in current, as well as voltage, burns brilliantly and gives long life.

THE STIRLING COMPANY, manufacturers of the Stirling water tube safety boiler, sends us a copy of a recent report of a test by Prof. Geo. H. Barrus on a Stirling boiler at the power house of the Portland (Me.) Railroad Company. Mr. Barrus ports that "the best results obtained, namely, an evaporation of 12.06 pounds of water from and at 212 degrees per pound of combustible, might have been still further improved by a further adjustment of the draught openings."

QUEEN & CO.'S portable photometer is meeting with a very considerable sale among the cities where the arc lighting companies are not giving satisfactory service. Scarcely a week passes without inquiry from city and town officials dissatisfied with the quality of lighting afforded them. Then the city electrician investigates the instrument, and finding how comparatively simple is its operation and how portable it is, and that it is the only portable photometer in America, naturally recommends its purchase by the municipal government.

THE STANDARD UNDERGROUND CABLE COMPANY, of Pittsburgh, reports an order this week from the Philadelphia Traction Company amounting to about $300,000, which, in connection with the order obtained last June from the same company, amounting to $250,000, represents over half a million of business from this company alone—a strong indorsement of the wire manufactures of the Standard Underground Cable Company, and reflecting credit upon Vice President Marsh and Eastern Manager G. L. Wiley, the popular officials of the company.

THE ELECTRIC APPLIANCE COMPANY is beginning the usual spring campaign on the swinging ball lightning arrester, and is meeting with its usual success. The swinging ball lightning arrester is particularly adapted for a line arrester, and is almost exclusively used in this way. The manufacturers promise something new this season in a station arrester built on an equally effective principle, and claim that an equipment combining the swinging ball lightning arrester on the line and its station arrester at the station will afford unfailing protection.

THE BRUSH ELECTRIC COMPANY held its annual meeting on March 26, at the office, on Belden street, Cleveland. The officers' reports indicated a prosperous business, despite the financial conditions that have existed. The organization for the ensuing year is unchanged, with one exception—the election of Mr. S. M. Hamill as second vice president. He will also retain the managership of the works. The other officers elected are: Pres-

ident, W. H. Lawrence; first vice president, C. A. Coffin; treasurer, B. F. Miles; general counsel, W. B. Bolton; secretary, A. H. Hough; assistant general manager, L. H. Rogers; superintendent, C. W. Phipps; assistant superintendent, C. N. Black.

MR. E. J. SPENCER has severed his connection with the General Electric Company, and has opened an office at Room 513, Security Building, St. Louis, Mo., as a consulting and contracting electrical engineer. Mr. Spencer, by his experience of nearly nine years in the corps of engineers in the United States army, by three years' special work in the factories of the Thomson-Houston Company, at Lynn, Mass., and recently for more than a year in charge of the installation, maintenance and removal of the exhibit and materials of the General Electric Company at the World's Fair, is well prepared for the line of work he has chosen, and no doubt will meet with the success his ability and experience merits.

MESSRS. VALLEE BROS. & CO., now at 17 North Sixth street, Philadelphia, will remove to 617-619 Arch street about April 15. They will have in their new quarters two large floors, each being 30 by 160 feet, which will give them increased facilities to handle their large and rapidly growing business. It is their intention to carry a full line of electric railway, telephone and telegraph supplies, as well as their well known line of electric light supplies, which will also be largely increased. The business of this firm has grown to such large proportions in the past two years as to render their present establishment totally inadequate to handle their business with proper convenience, and they were consequently forced to seek larger quarters. They have arranged to issue a catalogue of the various supplies they are selling, which will be mailed to their customers as soon as completed.

JOHN WOOD, JR., of the Schuylkill Foundry and Machine Works, Conshohocken, Pa., is sending out a catalogue containing interesting information concerning Wood's patent water tube steam generator, which also describes the many advantages of the system. There are many thousands of horse power of these boilers in use, and the partial list of some who have adopted them shows that they have been subjected to years of test in nearly every service connected with manufactures and electric plants, and the many duplicate orders are evidence of the results obtained. The advantages claimed for these boilers are: The large amount of efficient heating surface and the small space occupied for the power required; their rapid and economical steam generating powers and easy accessibility for cleaning to all parts, externally and internally; their great strength and durability and freedom from disastrous explosions, and from cast iron headers, manifold and numerous joints; they have more water and steam space than possessed by any other boiler, and a perfect circulation of water, producing remarkably dry steam. As the water tube type of boiler has become almost universally adopted throughout all parts of the world, it has caused many different makes to be introduced on the market, many of which have serious objectionable features, such as numerous headers, and so much cast iron in their construction. The Woods boiler obviates these objections, and being constructed on simple and scientific principles, and made throughout of the best open hearth wrought steel, it requires little or no repairs, and effects the highest economy in the use of fuel.

Business Notices.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

OPEN AND CLOSED CIRCUIT CELLS.—The Hayden carbon Porous cup No. 1 cell; the Hayden carbon porous cup No. 2 cell; a Leclanche clay porous cup cell; a standard Fuller cell; a No. 2 Fuller cell; a single cylinder carbon cell; a double cylinder carbon cell. All reliable and efficient and at prices lower than ever. THE HAYDEN-BOOKER MFG. CO., 2140 DeKalb St., St. Louis, Mo.

THREE BEAUTIFUL ETCHINGS.—The latest additions to the famous "Four-Track Series" etchings, issued by the passenger department of the New York Central, consist of three beautiful and highly interesting views, entitled respectively:

No. 6.—"The Empire State Express"—Fastest Train in the World—from a photo by Yates, of Syracuse, taken while the train was running over 60 miles an hour.

No. 7.—"Horseshoe Fall, Niagara," from a photo by Jackson, of Denver. Probably the grandest and most realistic picture ever made.

No. 8.—"Gorge of the Niagara River," from a photo by Jackson, of Denver. A beautiful view of one of the most wonderful features of Niagara.

The titles of the other five etchings comprising the series are: "Washington Bridge," "Rock of Ages, Niagara Falls," "Old Spring at West Point," "999 and the DeWitt Clinton" and "Rounding the Nose, Mohawk Valley."

These etchings are all printed on fine plate paper, 24 by 32 inches, suitable for framing. A copy of any one of them will be mailed in a stiff tube, secure from injury, to any address, for 75 cents, by George H. Daniels, general passenger agent, Grand Central Station, New York.

Illustrated Record of Electrical Patents.

U. S. PATENTS ISSUED MARCH 20, 1894.

(In charge of W. A. Rosenbaum, 177 Times Building, New York.)

516,641. POLICE SIGNAL; M. J. Burns, Lowell, Mass. Application filed Oct. 26, 1893. This comprises transmitters adapted to send signals, a central station and apparatus for distinguishing and recording the calls, two circuits, including several transmitters and the central station, a stable, and a loop extending thereto from one of the circuits.

516,642. MAGNETO TELEPHONE; H. A. Chase, Boston, Mass. Application fied Aug. 12, 1893. The combination, with an inclosing case, of a permanent magnet, having one end free from the case, and provided at its opposite end with a pole piece rigidly attached to a permanent magnet, and a support for the pole piece attached to the inclosing case.

516,643. MAGNETO TELEPHONE; H. A. Chase, Boston, Mass. Application filed Aug. 12, 1893. The combination, with an inclosing case, of a U-shaped magnet located within the case, a magnetic strip attached to the rear of the magnet, a magnetic ring supported by the case and to which the strip is connected, a cap or mouthpiece and an inductive diaphragm in proximity to the mouthpiece and magnetically connected to the ring.

516,651. AUTOMATIC SPEED REGULATOR FOR ELECTRIC MOTORS; W. Hochhausen, Brooklyn, N. Y. Application filed Nov. 26, 1889. The combination with a switch rod mounted on a conducting plate, of underlying springs electrically connected with the plate on which the rod moves, and having upturned ends, which engage with the bar.

516,653. GRAVITY BATTERY; L. F. Lary, Pottersburg, Ohio. Application filed May 23, 1893. An electrode formed by a sheet of material bent into cone shape and having an aperture at its bottom, the electrode being adapted to serve as a receptacle for an excitant and being also adapted to be unfurled and flattened out so as to facilitate the removal of chemical formations.

516,666. ELECTRIC RAILWAY SYSTEM; E. Thomson, Swampscott, Mass. Application filed May 29, 1891. The combination of a supply conductor and a section conductor connected thereto through a resistant, and an electrically propelled vehicle making successive connection with the conductors.

516,689. INCANDESCENT LAMP; G. C. Swan, Brockton, Mass. Application filed Dec. 30, 1893. A lamp having the leading-in wires passed through a flat metallic disc lying at right angles to the longitudinal axis of the bulb, the periphery of the disc being fused to the inner surface of the bulb, and the periphery of the stem being fused to the edge of the hole through the disc.

516,708. ANNUNCIATOR; C. A. McCordy, Fulton, N. Y. Application filed June 28, 1893. A bracket provided with spring fingers pivoted therein, having their outer ends held together by fusible solder and their inner ends provided with means for drawing them in contact with a bar to complete the circuit when the solder is melted.

516,713. ELECTRIC DEVICE FOR PUMPING OIL WELLS; H. F. Waite, New York, N. Y. Application filed Sept. 28, 1893. The combination with the pipe of an oil well, of a series of electric motors mounted therein at different distances from the bottom, each motor being directly connected with a propeller in the pipe, a source of electric energy, and connections between the source and the motors.

516,732. COMMUTATOR; E. R. Francis, Minneapolis, Minn. Application filed May 13, 1893. A commutator having alternate terminal plates constructed with interlocking segment stubs and alternate contact segments removably secured to the segment stubs.

516,740. ELECTRIC APPLIANCE FOR HORSES; G. R. King, Dallas, Tex. Application filed March 18, 1893. This comprises a belt carrying electric generating devices and a yielding contact plate under the belt adapted to be moved to operate the generating devices.

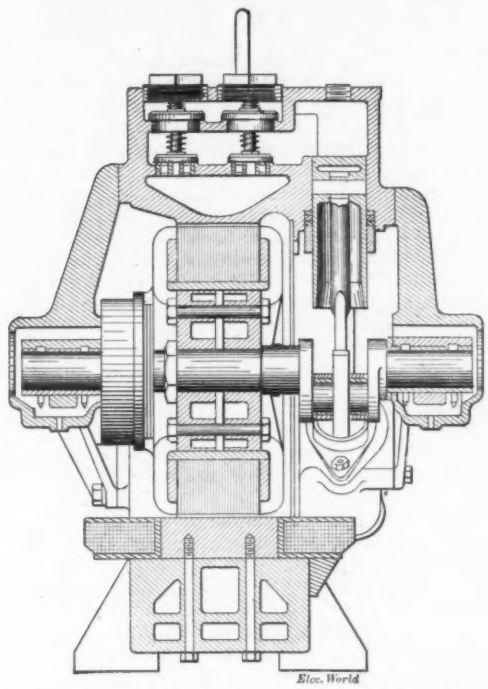
515,771. BURGLAR ALARM; W. Ritzmann, Chicago, Ill. Application filed June 12, 1893. The combination of a movable plate having a rounded metallic contact point and a companion plate provided with a barrel spring, and a metallic spring contact held normally flush with the surface of the companion plate.

516,777. TELEPHONE SWITCH; A. Stromberg and A. Carlson, Chicago, Ill. Application filed Sept. 21, 1893. The combination with a horizontally shifting telephone hook yieldingly maintained at one end of its travel, of a bracket, one edge thereof occupying a position between the members of the hook, and

Thomson, Swampscott, Mass. Application filed June 9, 1891. The combination in a regulating transformer of a fixed coil, a partly counterbalanced movable coil, one of the coils being in the main and the other in the work circuit.

516,847. MEANS FOR REGULATING ALTERNATING CURRENTS; E. Thomson, Swampscott, Mass. Application filed July 1, 1891. The combination of mutually inductive coils, one or both being vertically movable and suspended so as to be partly counterbalanced and subject to a constant gravitating force.

516,848. ARMATURE WINDING; E. Thomson, Swampscott, Mass. Application filed Nov. 16, 1892. An armature having



NO. 516,840.—ELECTRICALLY OPERATING PUMP.

undercut coil chambers, to which entrance is had through narrow openings in the surface of the armature, and coils surrounding the projections between such recesses, each wound in two layers, having the ends of the coil at the external part of the layers.

516,849. ALTERNATING CURRENT ELECTRIC MOTOR; E. Thomson, Swampscott, Mass. Application filed June 17, 1893. The method of operating an induction motor for alternating currents, which consists in partly closing the armature coils as local circuits at starting, and subsequently wholly short-circuiting the armature coils.

516,850. ELECTRICAL TRANSFORMER; E. Thomson, Swampscott, Mass. Application filed June 28, 1893. In a transformer, a casing interposed between the core and the coils, and filled with insulating fluid, the casing being provided with an insulating joint and openings for the leading-in wires.

516,853. COMMUTATOR CONNECTOR; O. N. Turner, Lynn, Mass. Application filed June 14, 1893. This comprises rectangular segments, slits cut therein, fastening pieces fitting the slits and engaged thereby, and armature connection electrically and mechanically connected to the segments by means of the slits and fastening pieces.

516,855. ELECTRICAL MEASURING INSTRUMENT; E. G. Willyoung, Philadelphia, Pa. Application filed June 23, 1893. The combination of permanent field magnets, an inclosing case, a pivoted armature arranged to move between the poles of the magnets, terminals exterior to the case and electrically connected with the armature coils, a dial plate, and a pointer movable over the dial plate, and moved by the armature.

516,862. SWITCHBOARD; E. F. Frost, Washington, D. C. Application filed May 31, 1893. A switchboard composed of a plurality of hinged leaves.

516,876. CONDUIT FOR ELECTRIC RAILWAYS; H. A. F. Petersen, Milwaukee, Wis. Application filed March 10, 1893. This comprises a conduit divided into two passages, one arranged to contain the conductors, and the other having the slot in its upper wall arranged out of line with the passage containing the conductors, and a suitable cover arranged to normally close the pasage in which the conductors are located.

516,878. ELECTRIC CIGAR LIGHTER; J. Sachs, New York, N. Y. Application filed Feb. 2, 1893. The combination of a handle, passages, plugs normally disconnected therefrom, conducting mains in the passages for connecting the plugs, and an exposed heating conductor connected to the plugs.

516,879. FIRE TELEGRAPHY; S. J. Sanford, Barrie, Canada. Application filed Feb. 3, 1891. This comprises a street alarm box having a number wheel with a spiral thread formed on the rim, and teeth formed on the thread, in combination with a weighted circuit breaker, dog and projection running in the slot.

516,892. INCANDESCENT LAMP; R. Langhans, Berlin, Germany. Application filed April 18, 1892. An exhausted lamp bulb provided with leading-in wires sealed into the same, consisting of a core or body of an alloy of one or more of the magnetizable metals with antimony, and a coating of platinum enveloping the same.

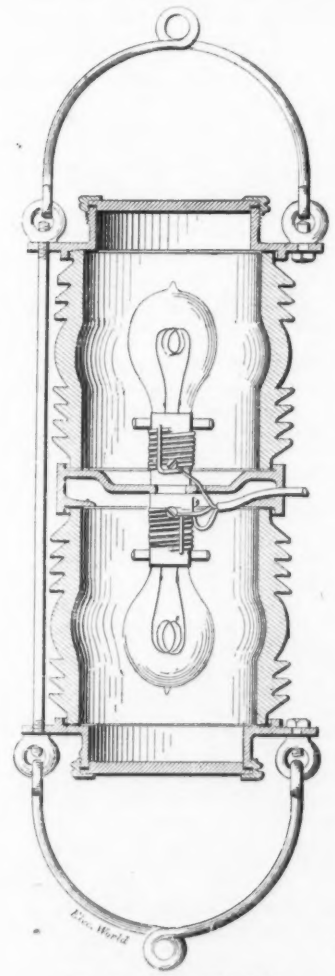
516,903. RAILWAY SIGNALING AND SWITCHING APPARATUS; J. D. Taylor, Chillicothe, Ohio. Application filed Dec. 14, 1892. The combination of a motor, a pair of crank shafts connected therewith by gearing, a transversely slotted and perforated rod connecting one of the cranks with the switch rail, and a connecting rod connecting the other crank with the bolt of the rail lock.

516,916. ELECTRIC MOTOR; C. J. Coleman, Chicago, Ill. Application filed Jan. 21, 1893. A motor having its field and armature adapted to rotate in opposite directions, and gearing connections of a differential nature between each of the same and the driven shaft.

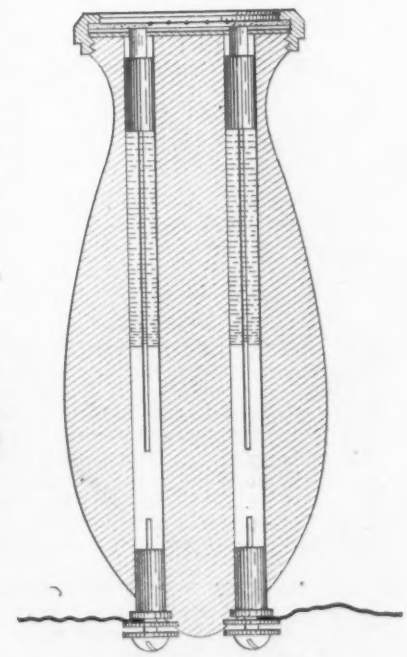
516,917. ELECTRIC MOTOR; C. J. Coleman, Chicago, Ill. Application filed Jan. 21, 1893. A motor having its field and armature adapted to rotate in opposite directions, in combination with an epicycle train of gears, forming a connection between the field, the armature and the driven shaft, and clutch mechanisms for independently holding the field and armature from rotation.

516,956. ELECTRIC ELEVATOR; R. Watson, Washington, D. C. Application filed Nov. 13, 1893. The combination with a motor, of an electrically controlled device for cutting in and out resistance in the armature circuit, a circuit extending to the car for controlling the device, and a rheostat in the car for varying the resistance in the latter circuit, whereby the speed of the car may be regulated.

516,982. TELEPHONE; A. C. White, Boston, Mass. Application filed Nov. 8, 1893. The combination with a diaphragm having one side inclosed or cut-off from communication with the medi-



NO. 516,824.—SIGNAL LANTERN.



NO. 516,878.—CIGAR LIGHTER.

um to which the other side is exposed, of a pressure equalizing or compensating device.

517,009. EXTENSION ELECTRIC CHANDELIER; A. McLean, Ansonia, Conn. Application filed Aug. 7, 1893. This consists of an outer tube and an inner tube, rods rigidly fixed in one of the tubes, and tubes rigidly fixed in the other tube, the rods and tubes having electrical connections at their outer ends and the inner and outer tubes being adapted to slide upon each other in raising and lowering a chandelier.

contact points controlled by the telephone hook.

516,784. ELECTRIC MOTOR; P. Wuest, Jr., Philadelphia, Pa. Application filed May 16, 1892. The combination of the pole pieces, the armature, brushes, studs projecting from the pole pieces for the brushes, a non-conducting sleeve between the brush holders and the studs, and non-conducting sleeves between the brush holder and the field magnets.

516,792. DYNAMO ELECTRIC MACHINE AND MOTOR; N. C. Bassett, Lynn, Mass. Application filed Aug. 31, 1893. A dynamo having a field magnet frame composed of two substantially triangular parts, meeting along their longer sides and hinged together at one end.

516,794. ARMATURE FOR DYNAMO-ELECTRIC MACHINES; L. Bell, Boston, Mass. Application filed March 17, 1893. An armature provided with laminated teeth, the laminae arranged in groups, separated by ventilating spaces.

516,795. ARMATURE FOR INDUCTION MOTORS; L. Bell, Boston, Mass. Application filed April 3, 1893. This comprises a core, copper bars extending longitudinally along the surface thereof, and a metal disc of relatively high resistance, to which the bars are connected.

516,796. REGULATION OF MULTIPHASE SYSTEMS; L. Bell, Boston, Mass. Application filed June 15, 1893. The method of preserving the relative position of the phase in a multiphase system, the lines of which vary in resistance or self-induction, which consists in artificially raising the resistance of the lower resistance lines to that of the higher resistance lines.

516,797. COIL FOR DYNAMO-ELECTRIC MACHINES; L. Bell, Boston, Mass. Application filed Nov. 13, 1893. The combination with an inductive core having undercut coil chambers, of a separately constructed coil, consisting of a number of turns of wire, so wound that the cross section of the coil when completed is substantially the same as that of the coil chambers, but larger than the contracted openings thereof.

516,800. INCANDESCENT LAMP AND METHOD OF MANUFACTURING THE SAME; H. D. Burnett, Lynn, and S. E. Doane, Swampscott, Mass. Application filed May 17, 1893. The method of making incandescent lamps, which consists in placing the leading-in wires between the inner and outer tube, softening and compressing the tubes so as to seal in the wires, then sealing the outer tube to the neck of the lamp, exhausting the lamp by means of the inner tube, and finally sealing off the inner tube.

516,804. METHOD OF TRANSMISSION OF ELECTRICITY; J. P. B. Fiske, Lynn, Mass. Application filed May 3, 1893. This consists in varying the strength of the field of the generator supplying current to the motor.

516,805. TRANSMISSION OF ELECTRICITY; J. P. B. Fiske, Lynn, Mass. Application filed May 3, 1893. The combination of a generator having a field magnet whose series coil is divided into sections, a series wound motor taking current from the generator, and a switch adapted to short circuit or cut in the sections of the field magnet coil of the generator, and thereby vary the speed of the motor.

516,806. OVERHEAD ELECTRIC RAILWAY; J. W. Gibboney, Lynn, Mass. Application filed Oct. 12, 1893. In a safety cut-out for electric railways, a trolley line divided into sections, feeders conveying current to the sections, fuses between the feeders and the sections, and means adapted to short-circuit the sections upon the track or ground return, and thereby rupture the fuses.

516,807. MOTOR ARMATURE; J. C. Henry, Westfield, N. J. Application filed Aug. 25, 1892. An armature whose coil has a loose but direct superficial contact with the commutator bars.

516,808. OVERHEAD ELECTRIC RAILWAY; J. C. Henry, Westfield, N. J. Application filed March 8, 1893. The combination with a pole having a vertical rack, of a transverse guy wire, having an eye or loop engaging with the rack.

516,818. ELECTRIC MOTOR; W. H. Knight, Lynn, Mass. Application filed Sept. 15, 1893. In a series wound electric motor, a differential shunt winding connected to its armature terminals adapted to respond to an increased speed of the armature.

516,819. INCANDESCENT LAMP; E. R. Knowles, Middletown, Conn. Application filed Dec. 9, 1892. The combination with a screw-threaded socket provided on opposite sides with parallel indentations, in which an insulating block is adapted to slide, and contact plates secured to the opposite sides of the block, each having a spring arm extending across the inner edge of the block.

516,820. SOCKET FOR INCANDESCENT ELECTRIC LAMPS; E. R. Knowles, Middletown, Conn. Application filed Dec. 9, 1892. In a lamp switch, a washer of compressed fibre or other insulating material, having one or more teeth on one face, and four ratchet teeth on the other face.

516,821. ELECTRIC SEARCHLIGHT; E. R. Knowles, Middletown, Conn. Application filed Jan. 9, 1893. A diverging lens for a searchlight, comprising two frames, each holding a set of alternating plano-convex and plano-concave strips of glass.

516,822. ALTERNATING ELECTRIC ARC LAMP; E. R. Knowles, Middletown, Conn. Application filed Jan. 8, 1893. The combination with a carbon holder having a cross bar, of a feed rack having a transverse foot, and a plate of slate interposed between them.

516,823. ELECTRICAL MEASURING INSTRUMENT; E. R. Knowles and L. T. Robinson, Middletown, Conn. Application filed Feb. 25, 1893. An ammeter comprising two or more magnetic needles, one of which is given a lead over the other or others.

516,824. ELECTRIC SIGNAL LANTERN; E. R. Knowles, Middletown, Conn. Application filed April 17, 1893. This comprises two cylindrical lenses, a diaphragm between them, two annular heads having flanges and necks, lids, and clamping rods passing through the heads.

516,825. ELECTRIC ARC LAMP; E. R. Knowles, Middletown, Conn., and E. H. Park, Milbury, Mass. Application filed May 25, 1893. In a horizontal arc lamp, a carbon holder comprising a horizontally turning wheel, a rocker hinged to the wheel on a horizontal axis, and clamping jaws carried by said rocker.

516,826. ELECTRIC ARC LAMP; E. R. Knowles, Middletown, Conn. Application filed July 17, 1893. In a focusing arc lamp, the combination with the shunt circuit, of a pair of contact points, one of which slides in a holder and is provided with adjustable stops, and a vibrating arm playing between the stops.

516,827. COMMUTATOR CONNECTION; C. A. Lieb, New York, N. Y. Application filed July 18, 1893. This comprises a slotted segment, and a connector having elastic sides wedged into the slot and retained therein by their tendency to spread apart.

516,829. COOLING ELECTRIC APPARATUS; W. S. Moody, Lynn, Mass. Application filed July 1, 1893. This consists in supplying to the apparatus to be cooled a flow of cooling fluid proportioned to the current passing therein.

516,831. STARTING AND CONTROLLING DEVICE FOR ELECTRIC MOTORS; J. W. Moore, Boston, Mass. Application filed Nov. 25, 1893. The combination of an armature circuit divided into two branches or lines, one provided with a variable resistance and the other with a constant resistance, a solenoid, a switching device for opening and closing the armature circuit, a contact arm connected with the core of the solenoid, and with starting mechanism controlled by the operator, the operation of the solenoid being dependent upon the influence of the counter electromotive force of the armature.

516,834. SERIES PARALLEL CONTROLLER; E. D. Priest, Lynn, Mass. Aplication filed Dec. 1, 1893. The method of changing three or more motors from series to parallel connection, which consists in shunting one motor, disconnecting it from the series, and connecting it in parallel with another, but in series with the remaining motors, and afterwards successively shunting the remaining motors, respectively disconnecting them from the series and bringing them into parallel with those already in parallel.

516,835. SYSTEM OF ELECTRICAL DISTRIBUTION; E. W. Rice, Jr., Swampscott, Mass. Application filed March 6, 1893. This comprises compound wound dynamos connected in multiple through bus bars to groups of feeders supplying the principal current, in combination with other over-compounded current sources of higher potential supplying the distant portions of the circuit through independent groups of feeders.

516,836. SYSTEM OF ELECTRICAL DISTRIBUTION; E. W. Rice, Jr., Swampscott, Mass. Application filed May 5, 1893. This comprises a source of alternating currents, lines leading therefrom to a point of distribution, and means adapted to commute the currents and deliver them to mains feeding translating devices by the three-wire or series multiple system.

516,837. ARMATURE FOR DYNAMO-ELECTRIC MACHINES; E. W. Rice, Jr., Swampscott, Mass. Application filed Nov. 16, 1893. This comprises a core having transverse undercut notches in the surface thereof, separately wound coils of such size as to be inserted in the narrow openings of the notches into the undercut recesses therein, and keys holding the coils in the recesses.

516,839. MEANS FOR MEASURING ELECTRIC CURRENTS; L. T. Robinson, Middletown, Conn. Application filed Aug. 24, 1893. In an electrical measuring instrument, a removable scale provided with a resistance.

516,840. ELECTRICALLY OPERATED PUMP; C. Robinson, Lynn, Mass. Application filed Oct. 11, 1893. A casing for an electrically operated pump mechanism, formed with interior channels and projecting consequent pole pieces, all adapted to form a magnetic yoke for the field magnet cores.

516,843. ELECTRICAL HOISTING APPARATUS; H. C. Spaulding, Boston, Mass. Application filed Feb. 12, 1890. The combination of the armature and inclosing winding drum forming the field of an electric hoisting machine, with gearing between the armature and drum, outside the latter.

516,844. LAMP SOCKET; A. Swan, Schenectady, N. Y. Application filed April 3, 1893. A socket molded in a single piece inclosing two stampings and a screw-threaded brass piece, one of the stampings being connected to the threaded piece, and the other being provided at its inner end with an aperture adapted to permit the passage of a screw.

516,845. METHOD OF CONSTRUCTING COMMUTATORS FOR DYNAMOS OR MOTORS; E. Thomson, Swampscott, Mass. Application filed Jan. 24, 1891. This consists of cast metal segments, and earthenware insulation separating the segments.

516,846. REGULATION OF ALTERNATING CURRENTS; E.